

EXPLORING FACTORS AFFECTING MATH ACHIEVEMENT
USING LARGE SCALE ASSESSMENT RESULTS IN SASKATCHEWAN

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Abstract

Current research suggests that a high level of confidence and a low level of anxiety are predictive of higher math achievement. Compared to students from other provinces, previous research has found that Saskatchewan students have a higher level of confidence and a lower level of anxiety for learning math, but still tend to achieve lower math scores compared to students in other provinces. The data suggest that there may be unique factors effecting math learning for students in Saskatchewan. The purpose of the study is to determine the factors that may affect Saskatchewan students' math achievement. Exploratory factor analyses and regression methods were employed to investigate possible traits that aid students in achieving higher math scores. Results from a 2007 math assessment administered to grade 5 students in Saskatchewan were used for the current study. The goal of the study was to provide a better understanding of the factors and trends unique to students for mathematic achievements in Saskatchewan.

Using results from a province-wide math assessment and an accompanying questionnaire administered to students in grade five across public school in Saskatchewan ($n=11,279$), the present study found statistical significance in three factors that have been supported by previous studies to influence math achievement differences, specifically in (1) confidence in math, (2) parental involvement in math and (3) extracurricular participation in math. The three aforementioned factors were found to be related to math achievement as predicted by the Assessment for Learning (AFL) program in Saskatchewan, although there were reservations to the findings due to a weak amount of variances accounted for in the regression model ($r^2 = .084$). Furthermore, a multivariate analysis of variance indicated gender and locations of schools to have effects on students' math achievement scores. Although a high amount of measurement errors in the questionnaire (and subsequently a low variance accounted for by the regression

model) limited the scope and implications of the model, future implications and improvements are discussed.

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Chapter One

Introduction

Mathematics is generally perceived as a skill that is crucial to all aspects of life development. From tasks such as counting change for purchases, calculating grade averages or doing taxes, different levels of math skills are constantly in demand throughout our daily lives. Studies have suggested that a higher attainment in math at the high school level is predictive of a higher earning power (Rose, 2001; Statistics Canada, 2005). Mathematics is also the cornerstone for developments in the field of science and technology, where competency in basic mathematical theories is required to understand and pursue studies in engineering, physics or computer science. Due to the broad influence that mathematics has on our daily lives, it is often the main focus of education systems, where students' progress is monitored and evaluated on their understanding in mathematics rigorously.

Canadian students generally score higher than the worldwide average in math achievement as supported by the Program for International Student Assessment (PISA, 2003). However, there are provincial differences in math achievement in Canada. Subsequent studies performed by Canada's own national assessment program, previously named the School Achievement Indicators Program (SAIP; 2003, currently renamed as the Pan Canadian Assessment Program), have found that Saskatchewan students have scored lower in math than other Canadian students. This finding has provoked a provincial interest to explore factors that impact student achievement in mathematics in Saskatchewan.

Factors Affecting Achievement Differences

There are many potential factors affecting achievement differences in large scale testing. For example, factors such as curriculum designs, demographics, personality traits, parental involvement, and extracurricular involvement are just a sample of issues that have been suggested to play a large role in a student's learning (Chambers & Schreiber, 2004; Eccles et al., 1983; Joshi, 1998; Kopsoich, 2001; Reyes, 1984). International assessment programs such as PISA may not be an accurate index of how students achieving within the country because the methods of testing established are based on an agreement between the participating countries. Therefore, the focus and categories of the assessment were not necessarily aligned with local education curricula. Similar arguments could be made with respect to nationally administered assessments such as the SAIP (or PCAP), where levels of learning achievement may differ across provinces, resulting in an inability to compare student achievement intra provincially. In order to explore students' mathematics achievement within the province, assessment programs should be designed, collected and analyzed in order to account for the distinct educational system influences that each province exhibit locally.

Differences in personality traits have recently been explored as predictors of how students will perform in mathematics and other academic subjects. For example, studies have focused on the relationship between math and anxiety (Cates & Rhymer, 2003; Statistics Canada, 2002). However, only a few studies have examined the relationship between math and locus of control (Stipek & Weisz, 1981; Vinner, 1997), and math and confidence (Ma, 1999; Ma & Kishor, 1997; Mittelberg & Lev-Ari, 1999; Reyes, 1984; Stipek, Givvin, Salmon & MacGyvers, 2001). The lack of attention to these factors are largely due to greater literature availability for

anxiety related research in clinical psychology, whereas confidence and locus of control are considered to be interrelated to anxiety issues in students' lives.

It is also possible that demographic differences within the population may influence math learning. While some studies have suggested that a linguistic advantage in certain languages would allow for a higher achievement in math (Myers & Milne, 1988), others have attributed cultural differences in math achievement to the level of aspiration and the value of education to anticipated discrimination within the job market (Li, 2001; Tsang, 1988). Studies have found a significant difference in math achievement between students in rural areas compared to those in urban areas (Young, 1998). This may be of particular importance in Saskatchewan, as the demographics of Saskatchewan are diverse with a high rural and urban diaspora. In addition, Young's (1998) findings did not explain why rural students performed poorer in math achievement than urban students, nor did Young investigate the achievement differences specific to Saskatchewan. Lastly, gender has always been a focal point of study in math achievement, such that boys have always been thought to perform better than girls (Entwisle, Alexander & Olson, 1994). This study explores whether gender differences in math achievement persist in Saskatchewan.

Other factors have also been found to be effective in moderating students' math achievement. The level of extracurricular activities has often been associated with improved student learning, where studies have found students' participation in extracurricular activities to be effective in improving students' academic achievements (Dumais, 2006). This study explores whether students' participation in extracurricular activities that uses math would affect math achievement in Saskatchewan.

The level of parental involvement in education has been proven effective in improving students' academic achievement (Drissen, Smit & Slegers, 2005; Newman & Goldin, 1990; Pong, 1997; Sheldon & Epstein, 2005). Studies have found a positive correlation amongst the level of parental involvement and the level of academic achievement demonstrated by their children (Jeynes, 2005; Morgan & Sorenson, 1999; Sheldon & Epstein, 2005). Dissenters would argue for the opposite, specifically in the case of math education, as the level of parental involvement may dampen development in problem-solving strategies as dependency in parental aid increases (Wagner & Phillips, 1998). This finding supports the need for students in senior grades to seek help aside from that of their parents. Based on this notion, the use of tutors or other methods should be investigated for their effectiveness in helping a student's math achievement.

The lack of studies for a model of learning that investigates math learning trends in Saskatchewan presented a research gap for this study. A study examining academic preferences could be useful in demonstrating unique learning attitudes specific to Saskatchewan students. There are other factors that could affect the math achievement of students. Such issues noted in the previous section are only a sample of those that have been investigated in previous literature. The present study investigated the existence of such factors amongst the primary school students in Saskatchewan and its relation to math achievement. To demonstrate levels of math achievement, the results of large scale math assessments were used. The next section introduces mathematic education in Saskatchewan.

Assessment for Learning

The province wide math assessment program in Saskatchewan, entitled Assessment for Learning (AFL; Saskatchewan Learning, 2004), was designed to be synchronous with the

provincial curriculum, where questions were designed to probe learning objectives within the curriculum and an equal number of questions were developed to accommodate for a range of difficulty. The AFL program is administered annually to students in grades five, eight and eleven, and questions are provided in both English and French. Further information regarding the provincial math assessment is available in later sections.

To investigate factors that may affect math achievement, a questionnaire that prompts for students' preferences and reactions to mathematics is administered with the AFL program. The questionnaire, derived from the Opportunity-to-Learn initiative as designed by Saskatchewan Learning (OTL; Saskatchewan Learning, 2000a, 2000b), seeks to allow for a better understanding of personality or trait differences that may optimize the level of math achievement, while controlling for the diverse learning environments across the province. Although such data are often collected in most levels of large scale assessments, the analysis of such information is often inadequately descriptive or neglected as most educators and administrators use the results of large-scale assessments solely to compare school or division performances, without enough focus in providing solutions to individual improvements (Ungerleider, 2006).

Statistics Canada (2006) has conducted a preliminary study on the cause for higher levels of achievement in mathematics with the national assessment results, where they have attributed the level of anxiety towards math, level of confidence, parental education attainment and family socioeconomic status (SES) as contributing factors to achieving a higher score (PISA, 2003). From this finding, students in Saskatchewan had a sense of confidence and anxiety towards math similar to the national average, but scored significantly lower than the national average in math achievement (PISA, 2003). This finding is contradictory to the general model of math

achievement as demonstrated by students from other provinces, where students' level of confidence and anxiety towards math relates, as predicted, to students' math achievement. The current study determined if such effects exist in the AFL results, along with any factors that may affect math achievement to students in Saskatchewan.

Method of Analysis

The methods of analysis that were employed in the current study were exploratory factor analysis (EFA) and multiple regressions. EFA is a popular research method used to discover and determine variable sets that are relatively correlated between variables that belong in the same idea but independent or unrelated to others (Tabachnick & Fidell, 2006). Application of EFA in the field of education research is common in instances of instrument construction and for the purpose of data variable reduction when investigating for learning traits in students (DiIorio, 2005). Multiple Regression (MR) is also another popular research method used to account for variance in one variable using a set of predictor variables. There are many methods of employing MR but the use of linear modeling, the simplest variation, is commonly used in educational research to explain achievement trends and deficits (Gall, Gall, & Borg, 1999).

The current study utilized such methods to see if there are relationships between different learning environments and learning styles that may affect math achievement, in order to provide more information in math learning and development for educators in Saskatchewan by using data that have been previously overlooked. The following section extrapolates on the purpose for conducting the present study.

Purpose of This Study

The comparatively low level of math achievements on large scale assessment for students in Saskatchewan has been a cause for concern with researchers and policy makers within the

province. Improving accountability in student achievement is one of Saskatchewan Learning's development objectives as stated in their annual report (Saskatchewan Learning, 2007). In order to address this issue, Saskatchewan Learning has taken actions by gathering a committee to investigate the learning standards of this province to address issues such as the low math scores. In addition, there are also interests in exploring other learning differences that are significant in improving math achievement such as measuring Opportunity-to-Learn (OTL; Saskatchewan Learning, 2000a, 2000b). The current study investigated accounts of math achievement differences in grade five students through traits and personal dimensions. The use of elementary grade student results is to avoid complex explanations that may be needed to account for the numerous factors that would explain for learning differences in older adolescents. The purpose of the study is to provide a perspective of extraneous factors that affect math learning with students in Saskatchewan. In order to achieve such goals, the following research questions are raised to address such issues.

Research Questions

The present study was designed to investigate the following issues:

1. Are there identifiable factors amongst students in Saskatchewan that may affect academic achievement in math? If so, what are the factors?
2. Can student questionnaire responses, such as the ones designed according to OTL, be used to evaluate math achievement differences across Saskatchewan?
3. Does school location or student gender have a significant effect on math achievement differences?

Rationale for the Study

To date, there has been no published analysis on how Saskatchewan students are performing with math other than comparison studies to their achievement scores (SAIP, 2003). Furthermore, results from a large scale assessment in which Saskatchewan students participated have not been published for public scrutiny. The current study attempted to utilize the Math Assessment for Learning (AFL) program results collected in 2007 to analyze for factors that affect math achievement differences. Previous studies have investigated the use of national large scale assessment to: (1) compare for learning differences across Canada (PISA, 2006; SAIP, 2003), (2) investigate for factors affecting math achievement (Anderson et al., 2006), and (3) plot for a model of achievement in math learning (Joshi, 1998; Randhawa, Beamer & Lundberg, 1993); but to date there have been no published studies investigating math achievement differences amongst Saskatchewan students. Saskatchewan Department of Learning has completed preliminary studies and reports that compared differences by school and division in the form of educational indices and individual factor tabulations, but no summary studies have been completed across factors and their relations affecting math achievement. The goal of the present study is to utilize available information and corroborate with Saskatchewan Learning from an analytical perspective to explore for ways to improve math achievement in Saskatchewan.

Delimitations, Limitations, and Assumptions

The following section outlines the delimitations, limitations, and assumptions of the present study. As the current study involves a secondary analysis of pre-collected data, the design of the current study had to adapt to the limitation of the original study in order to fit the research questions stated.

Delimitations

1. The study was delimited to the response sample set of grade five students in the provincial public school system who participated in the Saskatchewan Learning Assessment for Learning Mathematics in 2007.
2. The study approached the issue of math achievement differences in Saskatchewan by identifying and analyzing the response pattern through a variation of responses in the student questionnaire.
3. This study utilized quantitative methods such as exploratory factor analysis and multiple regression methods in order to carry out the investigation.

Limitations

1. The study sample is limited to the students that were selected to participate in the Assessment for Learning (AFL) program. The generalizability of results to the representation of the students in Saskatchewan could be high because the assessment was completed by students in the Saskatchewan education system, but such conclusions could only be made with students in grade five since they were the only students tested. The reliability of the sample could be questioned as not all grade five students (i.e., schools in reserves and private schools did not participate) in the province completed the assessment, hence the results may not be entirely representative of the learning trends of all the students in the province.
2. The study used data provided by AFL, a program in the Ministry of Education also known as Saskatchewan Learning. The method of conducting secondary analysis restricted the possibility of exploring further alternatives if the data proved to be insignificant.

3. The study did not include factors such as SES or parental background; both have been suggested to be important factors dictating school achievement as the data were not collected in the original survey. In addition, no post hoc follow-up questions could be asked because of the nature of using a pre-collected dataset.
4. The internal validity of the questions asked may be questionable, as criteria for the questions were designed with no psychometric properties for justification, and no validity verification or reliability studies have been completed with the questions to the overarching theme prior to the study.
5. The study did not include information as to the representation of children with learning disabilities or other kinds of conditions that would affect learning habits and belief of the student.

Assumptions

1. It was assumed that participants responded truthfully to all questions asked within the questionnaire.
2. It was assumed that the curriculum and the quality of educational instructions are consistent across Saskatchewan. The quality of education is defined by the definitions and criteria as suggested by the curriculum developed by the Ministry.

From the criteria listed above, the goal of the current study was to explore how students in Saskatchewan differ in striving for math achievement. The following chapters include a detailed explanation of how the study was completed. Chapter Two includes a literature review of previous studies as well as evidence that support the factor affecting math achievement. Chapter Three includes an explanation of the methodologies and procedures used in the study.

Chapter Four disseminated the results of the data analysis, and finally Chapter Five discussed the results and interpretations of the findings of the study.

Definitions

The following section provides operational definitions for the terms continually used in the current study.

Math Achievement – Math achievement is measured by the large scale assessment designed by AFL for the purpose of this study. The results are based upon a 40 question multiple-choice section that was collectively designed by teachers and education researchers of Saskatchewan in 2007.

Assessment for Learning (AFL) – A department within Saskatchewan Learning in charge of administering, collecting, and evaluating achievement results for students across the province using large-scale assessment methods (Saskatchewan Learning, 2007).

Saskatchewan Learning (the Ministry) – Ministry of Education, Saskatchewan

Locus of Control – The preferences of how the students attribute their success and failure of their math achievement results are based on external vs. internal attribution of results. An example of external attribution would be similar to “I need a lot of luck”, where as internal attribution would be “I need to study a lot”. (Stipek & Weisz, 1981; Vinner, 1997)

Confidence – In the context of the present study, confidence is referred to how confident the student is with his or her ability to do math or to use math in life. (Reyes, 1984)

Parental Involvement – The level of involvement of parents in the student’s learning in math.

Extracurricular Activities – The frequency of student participation in extracurricular activities that use math or are involved with mathematics. An example of such activities is Math clubs or Chess clubs. (Dumais, 2006; Papanastasiou & Bottiger, 2004)

Rural Schools – Schools located in the areas of or in towns with a population under 10,000 people. (duPlessis, Beshiri, Bollman & Clemenson, 2002)

Urban Schools – Schools located in towns or cities with a population over than 10,000 people. (du Plessis et al., 2002)

Chapter Two

Literature Review

In order to provide a comprehensive background to the present study, this chapter reviews the research conducted on factors affecting math achievement across the world as well as the current education trends in Saskatchewan. The chapter is divided into four sections. The first section is a review of the context of large scale assessment, education assessment structures, and student demographic differences in Saskatchewan. The second section discusses the prevailing model of research related to mathematics learning. The third section is a summary of converging themes from the proposed models. The last section is the statement of hypotheses and expected results.

Mathematics Education in Saskatchewan

The purpose of this section is to highlight and review mathematics education in Saskatchewan. This section includes discussions of: (a) student composition of Saskatchewan, (b) the mathematics education goals of Saskatchewan, and (c) structures of Saskatchewan and the math assessment programs for students in Saskatchewan.

Students in Saskatchewan

The students in Saskatchewan are a diverse population with a range of learning environments. With 174, 000 students in the provincially funded education system in 759 schools across the province (Saskatchewan Learning, 2007), the Ministry of Education (also known as Saskatchewan Learning) has to be very flexible in devising a learning delivery system that is equally effective in remote environments, rural communities and urban areas. In addition, due to the small student population, the provincial education budget is also smaller compared to other provinces. As a result, the education system in Saskatchewan adjusts accordingly to

community populations. For example, there are currently 119 schools that participate in a Community School Program, which provides additional funding for schools in vulnerable communities to ensure students in achieving learning success (Saskatchewan Learning, 2007). To ensure and enhance quality of education in remote and rural areas, as well as schools that do not have the resources to participate in learning in a traditional classroom, alternatives are in place for rural students, including participation in an online supported learning unit as well as the option of participating via interactive televised instructions (Saskatchewan Learning, 2007). To enable learning opportunities for aboriginal students, programs such as the Cree Immersion Program, Indigenous Language Curriculum, and the First Nations and Metis Education Branch have been established in order to provide for a more accepting and positive learning environment for aboriginal students in Saskatchewan (Saskatchewan Learning, 2007).

The mathematics curriculum in Saskatchewan is designed in cooperation with teachers and educators in Saskatchewan and is coordinated by the Ministry (Saskatchewan Learning, 2004). The curriculum was designed with three distinct levels of learning: elementary (K-6), middle-level (grades 7-9), and secondary (grades 10-12). Each level has distinct categories of focus as devised by Saskatchewan Learning. The elementary level (specifically grade five) of learning is the focus of the current study. The components of math learning for grade five are listed in Table 1.

Table 1

The categories of learning objectives for math in grade five in Saskatchewan along with the corresponding numbers of questions in the multiple choice sections of the Mathematics Assessment designed by Assessment for Learning .

| Categories of Learning Objective in the Elementary Math Curriculum | Number of questions asked in the multiple choice section of the provincial math assessment |
|---|--|
| Problem solving | 0* |
| Data management and analysis | 5 |
| Numbers and operations | 11 |
| Fractions | 12 |
| Geometry | 5 |
| Measurement | 7 |

Note. * Problem solving as a concept is implied to be tested in all question items.

The focus of the current study is on student results on mathematics assessments from grade five for numerous reasons. The impact and effect of education are less influenced by other social and interpersonal factors at a younger age, where students in senior grades would be more susceptible to more complex influences that may not be easily explained as the relatively simple interactions that elementary students would experience. It should be noted that problem solving skills were expected to be the underlying focus and be demonstrated across all categories of learning. From the guidelines of the provincial curriculum design, Saskatchewan Learning has

devised a provincial assessment program to ensure accountability in the learning programs delivered across the province are explained in the following section.

The Mathematic Assessment Program in Saskatchewan

Education in mathematics has generally been perceived as one of the key indicators in education (Ethington, 1992). This belief is highly regarded across the world and the efforts of the Canadian education system are evident from the results of international assessments. Currently, there are three levels of large scale assessments being administered to students across Canada by hierarchy, with international, national and provincial levels of assessment. Internationally, the Program for International Student Assessment (PISA) is designed to compare countries abroad in the international assessment organized by the Organization for Economic Cooperation Development. From the last assessment, Canadian students at the age of 15 outperformed all other G8 countries in all aspects of the assessment (PISA, 2007). PISA is administered once every three years to participating countries, with each iteration testing for one of the three subjects in a rotation: Science, Mathematics, and Reading (PISA, 2003). Within Canada, the School Achievement Indicators Program (SAIP, recently renamed as Pan Canadian Assessment Program, PCAP) is a national program created to allow a joint assessment to be administered in all the provinces, such that academic achievement can be comparatively evaluated across provinces. Similar to PISA, this national assessment program tested students of age 13 and 16 randomly selected across Canada. The assessment is conducted annually in three year blocks, each year testing for one of the three subjects, mathematics, science, and reading and writing. The national assessment was redesigned as PCAP to reflect on the changes in curriculum jurisdiction that have taken place in Canada in the past decade (PCAP, 2006). The purpose of collecting results from this national assessment program is to improve provincial assessments as

well as to validate and set education priorities, along with assessing possible plans of improvement such as improvement programs in specific areas such as class sizes, curriculum focuses, or evaluation methods (CMEC, 2003).

The assessment programs at the international and national level are heavily focused on the study of mathematics and literacy. This is congruent with the provincial level of assessment in Saskatchewan where the newly developed provincial wide assessment program titled Assessment for Learning (AFL) focuses on reading and mathematics skills. While math and reading are currently being assessed province-wide, two more assessments that evaluate for student's social skills and science are to be designed and implemented within the next two years (Saskatchewan Learning, 2007). The purpose of provincial large scale assessments is to provide a quality indicator for education across the province.

Assessment for Learning

The AFL program began in 2002 as a pilot project and province wide administration was started in 2004. This province-wide assessment program was originally named as Provincial Indicators Program and was mandated by the AFL initiative by Saskatchewan Learning (2004). The AFL was designed as a formative assessment, which was intended to provide feedback to Saskatchewan Learning regarding what the students have been learning in the classroom and curriculum setting. This type of assessment design differs from the popular summative assessment, which is primarily used to summarize and report on the level of learning students have reached in that subject. The formative assessment design method was chosen by the Ministry to ensure a level of accountability in the provincial education system, a level of transparency on the student's progress, and to provide information and goals to improve the current education system in Saskatchewan (Saskatchewan Learning, 2004). The AFL initiative

was designed with the following aims: (a) to raise the level of student learning and achievement for all students, (b) to strengthen the capacity of teachers, (c) to strengthen the capacities of schools and divisions, (d) to raise the level of assessment literacy among educators and administrators, (e) to support the development of professional learning organizations, (f) and to strengthen the ability of school divisions to report to the public (Saskatchewan Learning, 2004).

The mathematics assessment of AFL began in 2002 and has been slowly developing as a province wide assessment (Saskatchewan Learning, 2007). The math assessment program is currently still in the voluntary participation stage, where schools are allowed to choose to participate, although all schools participated in the year 2007. All students in grades five, eight and eleven in the province were administered the assessment in 2007. The design of the assessment is a collaborative effort from education administrators and teachers across the province and curriculum designers with Saskatchewan Learning. The assessment is distributed across the province in a two-week window, where teachers are given two days to complete the assessment process. As a commitment to the aims of the department, the assessment questions are publically accessible along with the marking/answer guide after the assessment is completed. Descriptive statistics and summary results are released at the school and division level to disseminate how well students are doing in their respective areas.

In addition to the formative feedback provided by the assessment results, the Ministry had also designed a student questionnaire in order to explore the learning styles of students in the province. The questionnaire was modeled under the Opportunity-To-Learn framework (OTL; Saskatchewan Learning, 2000a, 2000b), where questions were designed to act as a social barometer to measure to the impact of student learning opportunities and produce new education policies that may affect student learning. Saskatchewan's OTL framework was adopted as an

indicator approach rather than a research approach (Saskatchewan Learning, 2000a, 2000b), therefore the question designs were more focused on reflecting on macroscopic societal trends (Saskatchewan Learning, 2000a, 2000b). As education administrators often seek ways to improve student results in large scale assessments, student questionnaire results and demographic trends have been used as explanatory factors to account for the achievement differences (Kopsovich, 2001). The present study takes account of the unique differences exhibited by the educational design and student demographics in Saskatchewan and utilizes the results of AFL as research data.

The Assessment for Learning (AFL) program is a vital part of education in Saskatchewan as it provides feedback from student learning and also allows for accountability with the education system. In order to understand what type of learning model is behind math achievement, the following section explains possible factors that affect math achievement, and how previous studies have explored and investigated for such factors.

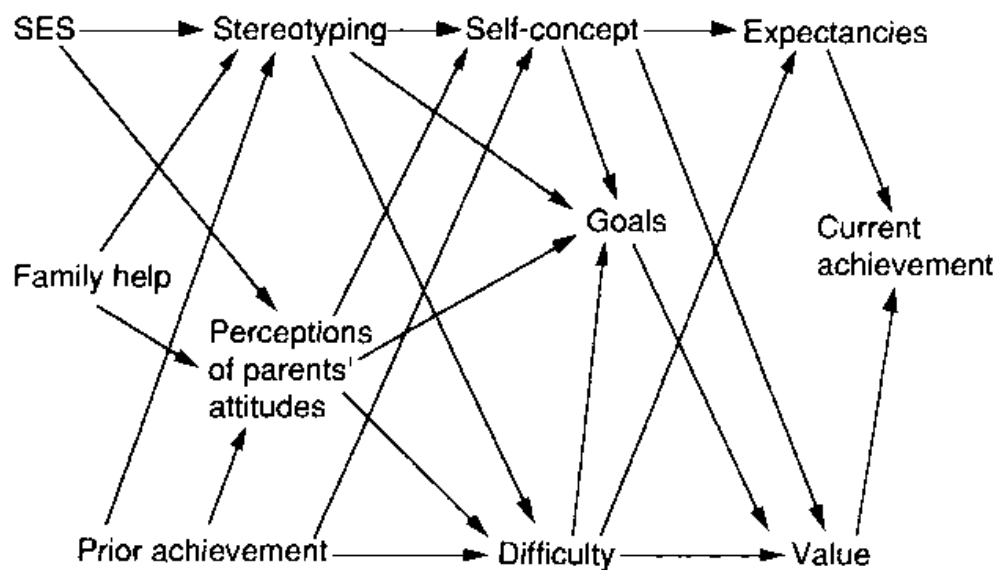
Theoretical Models on Mathematics Achievement

There have been numerous studies on events that would affect student's math learning. Researchers have compiled and suggested learning models in order to explain the interactions of such events in a hierarchical or sequential process also known as modeling. This section will review the previous finding of models that account for mathematics achievement.

The studies of factors that affect math achievement have been thoroughly discussed in the past, where studies have been conducted to explain different levels of learning. The model that is most popularly referenced to explain math achievement was proposed by Eccles et al. (1983). Eccles et al. (1983) proposed a predicting model of math achievement using such explanatory factors as self concept, expectancies, and family help perceptions of parent's attitudes, prior

achievements and difficulty of task as predictors of math achievement. The results of Eccles et al. study are important for the current study as they provide a historical precedence for research like the investigation of math achievement. The results also showed preferences with identifying math achievement variables by using path models, signifying that the contributing variables work in a sense of gradual process and level of improvements, not as definitive “have/have not” variables (see *Figure 1*; Eccles et al., 1983).

Figure 1. Diagram showing the model of mathematics achievement suggested by Eccles et al.(1983).



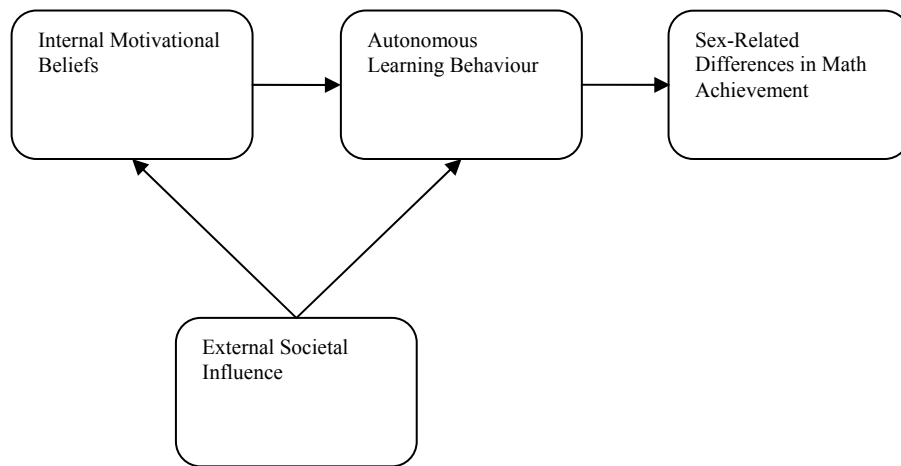
This model of math achievement provided a general working model for researchers to explore different methods of interventions or models that were comprised to cater towards specific populations or different learning populations (Fenema & Peterson, 1985; Parsons, Meece, Adler & Kaczala, 1982; Reyes, 1984). All subsequent models follow the design similar to Eccles et al. (1983). While the general model proposed by Eccles et al. (1983) has attempted to explain math achievement, the factors were not specific enough for students in the primary

grades. Reyes (1984) improved upon previous models to specifically examine factors that affect math achievement in elementary students.

Affective variables are variables that cause change to what is being measured. A study conducted by Reyes(1984) examined the affective variables in math achievement within elementary students by integrating a range of existing models of learning (Eccles et al., 1983; Fennema & Peterson,1985; Kulm, 1980). Reyes (1984) identified confidence, anxiety, attribution of success and failure, and perceived usefulness in mathematics as the four variables that interact to generate an effect on math achievement. Reyes argued that the level of student self concept is paramount in contributing to the four affective variables. By using social learning concepts posed by Bandura (1971), Reyes explained student math learning with the four attributes discussed, and that other peripheral attributes were indirect effects caused by the four attributes. However, Reyes used Fennema and Peterson's (1985) autonomous learning behaviour model to explain math achievement differences (see *Figure 2*), and did not explain why there was a sex-related difference in math achievement. The study simply explained the gender differences as contributing factors, and did not recognize the complexity of gender roles involved when studying learning and achievement. Reyes (1984) also argued that the students' level of perceived usefulness of math was a significant factor in predicting math achievement. While the study showed a significant effect in predicting for math achievement, the study focused only on teachers' perceived usefulness of math as an ameliorating factor, and neglected parents' perception in math (Reyes, 1984). The perception in the usefulness of math to parents should be a contributing factor to this variable; as the usefulness of math could be a learned trait from parents' reaction towards math problems. Wagner and Phillip (1992) supported such notion as

they found that the level of perceived expectation of the children's academic achievement is related to the level of perceived achievement exhibited from parents.

Figure 2. The Autonomous Learning Behavior Model from Fennema and Peterson (1983)



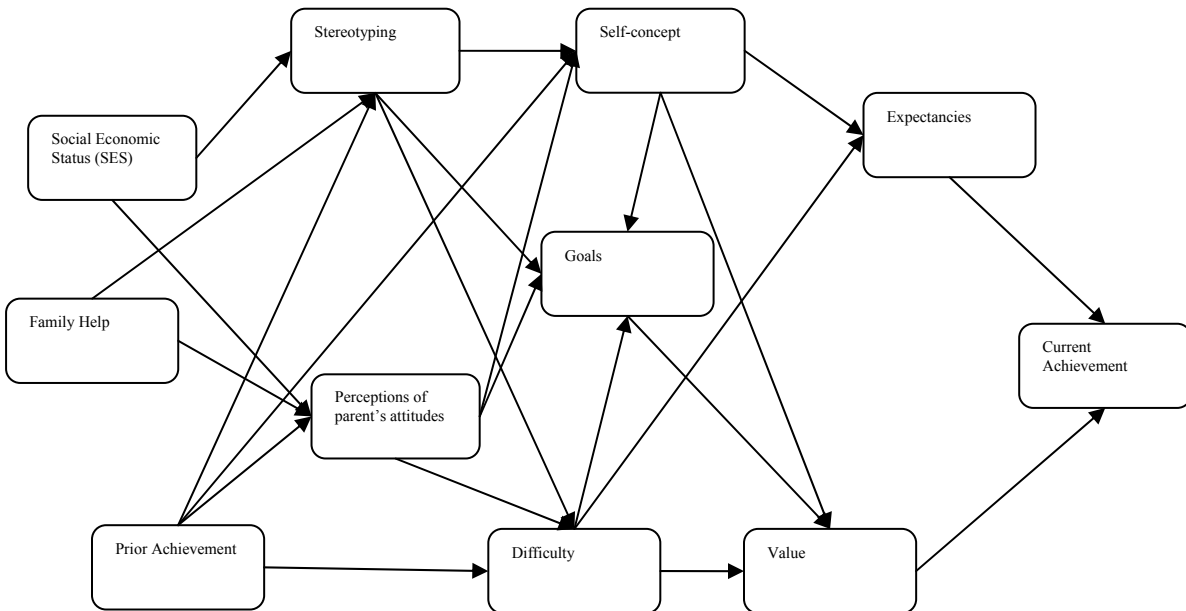
Applications of Theoretical Models

In a more recent study, Kopsoich (2001) examined the relationship between student's learning styles and their math scores on the Texas Assessment of Academic Skills test (TAAS; 1997). Kopsoich's study, based on 500 grade five students, correlated student learning styles with TAAS results using an inventory designed by Dunn, Dunn and Price (1989). The study used a combination of point bi-serial correlations and correlation tables to determine relationships between the learning styles, ethnic groups and gender with their respective math scores. Using the Learning styles Inventory (Dunn et al., 1989), the 22 different learning styles were investigated for differences between the three factors posed. The study found that the level of persistence was a factor in higher achievement in math. Furthermore, factors such as gender and ethnicity did result in a significant difference in math achievement, and also exhibited a significant and correlated difference in the level of persistence in learning (Chambers & Schreiber, 2004; Dumais, 2006; Kopsoich, 2001). This finding is significant as it demonstrated the comparison of students' learning styles with their levels of math achievement using large

scale assessment results. While Kopsoich's (2001) finding did show support for factors that prompt persistency in learning, there were some limitations to the study. For example, Kopsoich chose to conduct point bi-serial correlations on 22 dimensions within an instrument, while comparing against different groups such as ethnicity and gender for significant differences. This level of analysis is useful in understanding if there are similar trends in response sets across different groups, but is not useful in exploring whether there are any significant response differences between groups, or whether there are any overall trends that contributed to math achievement. The use of bi-serial correlations limited the investigation of relationships to an item to item basis, whereas there were groups of items or factors that are related to each other or confounding variables. Correlation studies would not be able account for such relationships.

A study conducted by Ethington (1992) expanded upon the levels of learning and modeling for math achievement in order to validate a model from Eccles et al. (1983). Ethington proposed a path model which explained cognitive processes prior to and after the actions within the general model of math achievement as proposed in Eccles et al. (1983). The purpose of creating a more complex model in predicting math achievement was to establish a psychological construct of influences on math achievement (see *Figure 3*). The subsequent purpose of the study was to see if there was a gender difference in the construct of math achievement. Ethington's study utilized a sample collected from the Second International Mathematics Study (SIMS; 1982).

Figure 3. Model proposed by Ethington to explain for math achievement behaviour. (1992)



Ethington (1992) used a causal modeling method based on least-squares estimates to determine the significance of paths. The findings of this study were convincing in modeling math achievement because all variables used in the model were shown to be significant in their path. When all the variables were plotted to predict current achievement, students' social economic status became unimportant in predicting achievement. Keith, et al.'s (1986) paper examined this relationship by exploring correlations between SES and math achievement. This finding suggested that SES was an indirect cause in predicting math achievement. Other variables such as the perception of parents' attitudes, availability of families for help, the expectations of students, and students' goals became more important in predicting current achievement. In addition, Ethington also found that men were easier to account for in the math achievement model (better fitness) than women. Women's achievement had a lower fitness to the model suggesting the existence of additional, unaccounted for factors in affecting math achievement. A limitation to Ethington's results was the use of a limited sample of grade eight students as her

sample population. This lack of generalizability in Ethington's (1992) study is problematic as the proposed learning models cannot explain essential learning behaviors developed at students' earlier ages.

Confirmation of Math Achievement Models

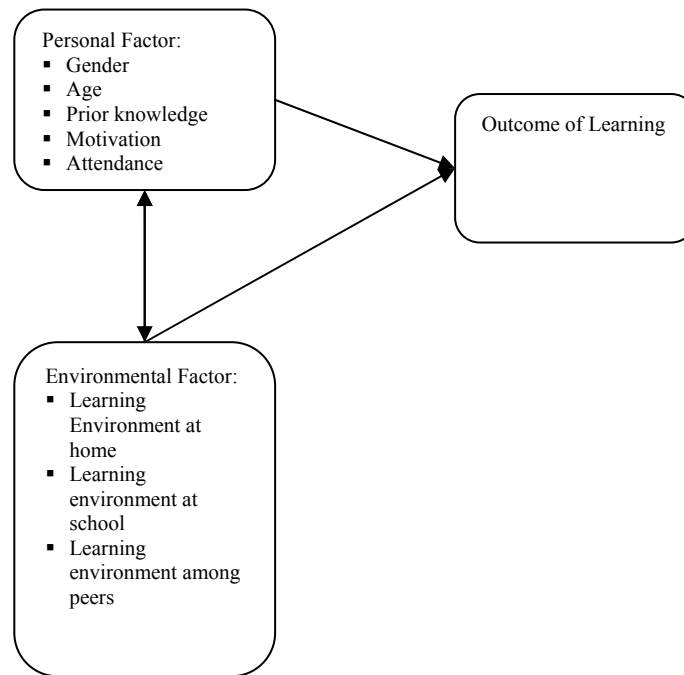
Joshi (1998) proposed a model that described overarching interactions in the factors that affect math learning. Using an international perspective, the study incorporated a model consisting of two latent variables predicting the math achievement of students in Nepal (see *Figure 4*). Joshi's (1998) findings were supported by the four contrasting social cognition learning theories and included seventeen factors that contributed to the two latent variables. The purpose of the study was to investigate the significant failure rate in mathematics testing at a secondary level, and to explore what types of support students would need in order to improve the level of math achievement in Nepal (Joshi, 1998). The four learning theories used are presented in Table 2.

Table 2

Four Distinct Learning Theories that Contributed to Math Achievement and Joshi's Proposed Model. Joshi (1998).

| Name | Variables | Note |
|---|--|---|
| Walberg's Educational Productivity Theory(1981) | Age, Motivation, Prior Achievement, Quantity of Instruction, Quality of Instruction, Home Environment, Classroom Environment, Peer Group environment, Mass media | Thoroughly studied to support the 9 variables were positive influences of student academic achievement. Studies also show factors interact of provide for optimization of learning when all factors are beneficial in supporting the student's learning |
| Coleman, Hoffer & Kilgore's Model of Student Achievement (1982) | Student's own background, other student's background, students own behaviour, other student's behaviour, school type, school policy | Coleman et al. (1982) suggested that school policy matters are directly affecting students' achievement as it provides a level of regulation that other environmental factors such as the teacher's teaching practices or their level of skill or commitment to teaching can be related. |
| Carroll's Model of School Learning (1982) | Student Aptitude, Student Ability to understand instructions, Student's Level of perseverance, Opportunity for learning, Quality of instruction. | Carroll (1982) suggested that the degree of student's learning is a function of the ratio of the amount of time the learner spends on the task to the total amount of time the learner needs. |
| Bigg's General Model of Student Learning (1985) | 3 Different Levels of Learning : Deep, Achieving, Surface. Personal Factors: Perseverance, Ability, Prior Knowledge, Personality, Home/Cultural background. | Bigg's (1985) suggested in each learning approach encountered by the student, there are different strategies and motives in learning. To actualize their learning, the student's own interest would have to be realized. The student needs to understand and organize the meaning of the task in order to optimally complete and learn from the experience. |

Figure 4. A math achievement model proposed by Joshi to explain for math learning and achievement differences in Nepal (1998).



From Joshi's summary of learning models, there are many similarities that can be generalized across the common factors. All models contain a factor that involves personal backgrounds of students in determining their levels of academic achievement. However, the levels of personal factors were interpreted differently across different models. Carroll's (1982) model focused on the level of quality and students' intrinsic abilities to learn or adapt to learning. The models suggested by Walberg (1981) and Coleman et al. (1982) were more focused on the level of abilities or student behaviour to attribute for personal behavioural differences. While Bigg's (1985) model focused on similar attributes as the previously discussed models, it attributed the students' depth of learning to their overall reflections of achievement. This difference of interpretation in personal factors affecting math achievement demonstrated the

need to identify personal factors that are specific in explaining math achievement in Saskatchewan students.

The summary of existing learning models has proposed, applied, and confirmed factors and models that can be used to explain math achievement differences. This study attempts to explore factors that would affect students' math achievement in Saskatchewan. In addition, different statistical analysis techniques were used in the current study to ensure that the dataset is properly explained, and that all possible relationships are explored. The current study samples a younger population to reflect on learning traits at an earlier age. The following section discusses the possible factors that have been known to effect math achievement.

Converging Factors

From the review of theoretical models, there are numerous themes that have been consistently explored by researchers as factors affecting math achievement. The present study has identified three themes that have been consistently shown to influence student learning in math: *Demographic Factors*, *Personality Attitude Factors*, and *Community and Extraneous Support*. The support for each of the themes is discussed in this section. The themes are non-overlapping, each having its own level of measures. A summary of the models reviewed are presented in Table 3.

Table 3

Previous Studies on Factors Affecting Math Achievement

| Author | Factors | Author | Factors |
|----------------------|---|-------------------------------|---|
| Eccles et al. (1983) | SES Stereotyping Self Concept Expectancies Family Help Perceptions of Parents Attitudes Prior Achievement Difficulty Goals Value | Kopsoich (2001) | Ethnicity Motivation Persistence Parent Figure Motivated Teacher Figure Motivated Responsibility Structure of Learning Learning Alone/Peers Authority Figures Present Kinesthetic Internal control (controllable by the person) |
| Eccles et al. (1982) | Skill or math knowledge Consistent effort Immediate effort Task difficulty Natural ability Interest in math Mood and internal state Teacher Classroom Environment Luck Unclassified. | Stipek & Weisz (2001) | External (outside of person control Stable or Unstable control Attribution differences failure and success |
| | | Chambers and Schreiber (2004) | Gender Extracurricular activities Organized/Unorganized Academic vs. non academic School or non school Ethnicity |
| Vinner (1997) | Conceptual/analytical Pseudo conceptual/pseudo analytical | Dumais (2006) | SES Race Gender |
| Joshi (1998) | Class attendance Parental support Peer interaction Teacher certification Teacher's experience Previous math background Location of school Achievement motivation Age Parental education Parental educational pressure | | Music lessons Dance lessons Performing arts Art lessons Athletics Clubs participation Self efficacy Locus of control Mathematics anxiety Learning outcomes Study habit Career aspirations Self Concept |

Demographic Factors

Studies have been conducted to differentiate and compare certain segments of the population to identify higher math achievement by: (a) gender (Marsh & Yeung, 1998), (b) cultural background (Barta & Shockey, 2006), and (c) the location of schooling (Young, 1998). The following section is focused on these topics to investigate the type of effects student demographic characteristics have on math achievement.

The difference in math achievement between men and women has been heavily debated as a factor influencing learning especially in math. Meece (1982) argued that the differences in achievement between men and women were due to social causal differences while Parsons et al. (1982) argued that the differences were attributed to true gender differences and not a cause of math achievement differences. The existence of contradictory findings perpetuates the issue of gender as a factor in affecting math achievement. Fan, Chen, and Matsumoto (1997) conducted a study to examine gender differences found in the results of the National Education Longitudinal Study of 1988. They found evidence to support the notion that girls have a significantly lower achievement in math than boys, with the difference increasing with the grade level. The scores were also found to be increasingly more extreme with girls, where there are high numbers of female students found to be either very successful or failing badly. Although the achievement gap was not found in the elementary grades, the learning discrepancy between genders originated from that time frame (Fan et al., 1997). Entwisle et al. (1994) supported the previous male biased finding in math achievement, and attributed the achievement differences to the perception of help available. Specifically, girls' perceptions of help offered in her surroundings would be different than boys' perceptions of help as males are more sensitive in seeing such opportunity (Entwisle et al., 1994). In addition, Parsons et al. (1982) suggested that math achievement differences

between boys and girls are further separated by girls having a higher level of helplessness in math than boys at a young age. While there were no achievement differences at the young age despite significant differences in the level of helplessness, Parsons et al. argued that future achievement differences in girls would stem from this prevalent feeling of helplessness in math. Chambers and Schreiber (2004) conducted a study on varying relations of extracurricular activities with girls' academic achievement and have found that non-academic extracurricular activities tend to have a negative relationship with math achievement. Although there are different interpretations as to why the gender gap exists in math achievement, no gender gap was identified for Saskatchewan students in the latest SAIP assessment in math (CMEC, 2003).

With only two major city centers, Saskatchewan has a comparatively large number of students residing in rural areas; 42% of Saskatchewan students received education in rural schools (Saskatchewan Learning, 2007). Characteristically different from urban schools due to lower attendance rates, rural schools suffer from issues such as having fewer resources and more grades in a single school (Kannapel & DeYoung, 1999). The notion of urban and rural schooling differences has often been argued in order to account for differences in academic achievement in students (Edington & Koehler, 1987; Kannape & DeYoung, 1999; Young, 1998). The most recent trends in educational research suggest that rural/urban differences account for such differences in achievement, although studies have found conflicting results.

There has been strong support within the literature for the notion that urban students perform better in math than rural students (Edington & Koehler, 1987; Greenberg & Teixeira, 1995; Randhawa & Michayluk, 1975; Young, 1998). In a dated but relevant study about rural education in Saskatchewan, Randhawa and Michayluk (1975) argued that rural classrooms in Saskatchewan are more disorganized in lesson implementations, and have a higher tendency to

deviate from the curriculum due to a higher teacher workload and classrooms with higher grade spread. It was also argued that rural schools have a difficult time in attracting high quality personnel in comparison to urban schools, with the latter having more students, resources and course offerings (Gutstein, 2003). Gutstein argued that the greater number of teachers in urban schools provide support to ensure teaching quality, as teachers have the opportunity to consult with and provide help for one another. Other studies have attributed the achievement differences to socioeconomic status differences between rural and urban communities (Alspaugh, 1992; Young, 1998) and school sizes (Wilson, 1985). From the arguments made, rural schools are considered to be disadvantaged resource-wise and academically inferior compared to urban schools, but other studies have found opposite results.

Studies have also found favourable results for rural students in math achievement. For example, Alspaugh (1992) found no rural/urban differences in math achievement. Beck and Shoffstall (2005) found rural students perform better than urban and suburban students in high stakes large scale assessments in math and sciences. Other studies have concluded that rural schools perform better than urban schools in classroom assessments (Alspaugh & Harting, 1995; Haller et al., 1993). The argument as to why rural schools do better than urban schools academically is based on the idea that students in rural schools are taught in a more applicable and practical manner due to lower student enrollment, and more time spent with students being the key factor (Fan & Chen, 1999). Most studies have shown no significant differences in math achievement between rural and urban areas, and it has been many years since a study has been published on the rural urban differences of education in Saskatchewan (Ranhawa & Michayluk, 1975).

The demographic factors explored in this section have been shown to be influential in affecting students' math abilities. Such factors as gender, cultural factors, and locations of schools have been discussed regarding their effects on math achievement. The next section looks at students' attitudes and personalities that may affect their learning in math.

Personal Attitude Factors

Attitudes and personal traits are paramount to a person's learning achievement. As mentioned in previous sections, studies have shown personal attitudes to cause significant differences in math achievement. Students' anxiety towards math has often been the focus of personal attitudes, with levels of anxiety towards math being detrimental towards math achievement (Ma, 1999). The present study focuses on the level of confidence and locus of control for math achievement as the level of anxiety is related to both factors.

Locus of control in the current study can be described as an attribution of error or success in the students' achievements in math. The general premise in locus of control is to identify whether success was attributed in two dimensions: internal or external and stable or unstable. Weiner (1974) suggested the students' success or failure attribution could be explained along those two dimensions. For example, if the result was attributed internally, the subject would likely be blaming or attributing their results to their own abilities. Whether they would be self-blaming or self-praising would be dependent on whether they see that event as a positive or negative attribution. Conversely, if a student were to externally attribute the results they receive, they may attribute their results to luck if it was an unstable attribution, or on the difficulty of the questions if it was a stable attribution. The process of causal attribution is important in math achievement as it determines how students handle feedback for their work. There have been

different theories as to which method of causal attribution would be most beneficial in students' learning.

Stipek and Weisz (1981) conducted a study to determine how success and failure are related to academic achievement. The authors found that intrinsic motivation relates heavily to the level of perceived control. This finding supports the notion that a higher level of academic achievement is related to an internal attribution rather than external events. For example, attribution of results towards their abilities (internal) could lead to a level of learned helplessness, as students would not be encouraged to try harder to learn because they believe that they have limited abilities. Moreover, if the cause of achievement were attributed in an unstable manner (i.e., luck), the student would be less likely to learn compared to a stable attribution of success (i.e., a level of effort they exert). This finding has been debated over the focus of question wording, where an external attribution of traits may be dependent on the difficulty of the question. Students' attributions could be biased towards an external attribution (i.e., the question was too hard) if questions were unclear to a student, where he or she would not realize that his or her internal attribution insufficiencies (i.e., they did not study enough) were true (Nicholls, 1978).

The type of causal attribution is an important factor for students as it optimizes their processes in learning math. It would be interesting to find which type of causal attribution is preferred by students in the province. The findings would be beneficial in identifying the level of support that may be needed in order to help students to further succeed in math achievement.

Level of confidence in math has also been shown to be a predominant trait that contributes toward learning. A high level of confidence prompts a higher likelihood for students to respond to questions and also a lower level of anxiety in the subject tested. This effect would

allow students to achieve better academically because they are more confident in their responses and are more willing to answer questions or solve problems (Lawrence, 1985). While this effect may hold true in developing reading skills and other motor skills (Laszlo & Sainsbury, 1993; Lawrence, 1985), it is debatable as to what effect the level of confidence in math has on math achievement.

Ma & Kishor (1997) conducted a meta-analysis on the strength of the relationship between attitude and achievement in math, where they summarized more than 113 studies that examined attitudes of students towards math. Although they have found no significant trends as to whether a positive or negative attitude towards math affects math achievement, there were significant differences in level of confidence in math with the ability to solve and complete math problems (Ma & Kishor, 1997). Classically, the study of math confidence is tied to the level of self-concept, which had a history of maintaining a positive relationship with general academic achievement (Reyes, 1984). Self concept has been found to be consistent across gender (Adrian, 1978), and results in a positive correlation between assessment results and problem solving abilities (Reyes, 1984). Confidence in learning math is also reflected in large scale assessments, where studies such as the National Longitudinal Study of Mathematical Abilities found a moderate relationship with confidence along with achievement (Crosswhite, 1972). From the above past findings, there is strong support for hypothesizing that confidence would be a positive factor of math achievement, although recent studies have shown a high level of confidence may not be all beneficial in math learning due to overconfidence (Chen, 2002).

Jones and Smart (1995) conducted an intervention process on confidence level with students in math achievement. They found that a level of learned helplessness and a fear of success dominate the current perspective of math education, where students who are successful

in math did not have a high level of confidence. In addition, gender biased perceptions exist, as a high level of success in math is negatively viewed by their peers. The above study further reinforces the notion that students who may be successful in math may not have strong sense of confidence in math. Adeyemo and Adetona (2007) suggested that self concept is a crucial factor in math achievement and is a generalization of confidence in math learning, although they only demonstrated a 4% correlation of variance with outcomes of math achievement when the level of self concept was plotted in a path model. Another study suggested that the student level of confidence in math is dependent on the level of self-confidence of the teacher in their ability to teach math (Stipek et al., 2001), however Wagner and Phillips (1992) have found students' levels of academic confidence are related to their self-perceptions of their competences.

The above section has demonstrated the different effects that personal factors have on math achievement. From the summary of models and previous research, the factors that would be evident in effecting math achievement would be the students' levels of confidence in math and their locus of control in attributing their math achievement. The following section discusses possible extraneous factors that affect students' math achievement.

Community and Extraneous Support

Previous studies suggested that extraneous factors for learning such as quality of classroom environment, peer interactions, peer group study environment, and learning environment at school have an effect on students' math achievement. The current study will focus on the schools' quality of instruction and levels of support amongst peers' extra-curricular factors as the extracurricular factors that affect the students' math achievement, because the factors are mandated to be equal across all schools (Saskatchewan Learning, 2004), and are uncontrollable from the perspectives of students and parents. As the current study tries to

identify extraneous factors that may aid and improve the level of math achievement in Saskatchewan, the factors investigated should be malleable to help the level of math achievement.

The availability of parents to help is important to students' learning, but the level of parental involvement may have a different effect on student learning. The general belief is that the more time parents spend with their children regarding school work, the more likely their children will be academically successful. While this notion was tested to be true for elementary students (Drissen, Smit & Slegers, 2005), the difficulty in determining levels of help needed by each student is different for parents of ethnic minorities or low SES, as they may be less able to determine effective strategies in helping children with their school work (Drissen et al., 2005). Epstein (2001) established six different types of parental involvement with respect to being active with their children's education, the six factors are: (a) parenting, (b) communicating, (c) volunteering, (d) learning at home, (e) participating in school decision making, and (f) collaborating with the community. The six types of parental involvement are essential factors in providing services for student education. Drissen et al. (2005), based on a large scale dataset collected in the Netherlands, found ethnic minority parents were less likely to participate in their children's education and the effects of their involvement were not as evident compared to non-ethnic minority parents. This conclusion leads to the question of whether other types of differentiation exist in terms of parental aid. For example, Pong (1997) suggested that single parent families would lead to a negative effect on children's academic achievements even if demographics and backgrounds were controlled. McLanahan (1985) attributed this effect to the lesser amount of time the parents have to spend with their children. This finding was supported by Zill (1994), who found a lower level of parental involvement when the student was brought

up in a single parent household than a dual parent household. Findings on the differing effects of academic achievement by varying types of parental involvement signify that the relationship between parental involvement and academic achievement is not straightforward.

Jeynes (2005) conducted a meta-analysis of 41 studies to explore the relationship between parental involvement and elementary student academic achievement. The study found an overall positive relationship, which supported the main hypothesis, but a few contradictory findings were also discovered. The study did not find that having parents checking on their children's home work had a significant positive influence on academic achievement. Furthermore, there were mixed findings from the analysis for the parental involvement group, as over-involvement may also harm the effectiveness in students' academic achievements due to a development of dependence of the child on the parent's help (Jeynes, 2005). In addition, Morgan and Sorensen (1999) identified a negative relationship in students' achievements as parental networks developed to support their involvement within schools became more socially enclosed. This finding suggests as parents become overly involved with the process of their child's education, the level of academic achievement within their children may also decrease.

A common belief is that math skills will improve with more practice. Although students obtain practice for math from the assigned homework, there is a lack of opportunities to practice math aside from the assignment of homework. This lack of opportunities led to studies that investigated the effects of extracurricular activities on achievement. Sheldon and Epstein (2005) utilized longitudinal data to investigate the level of community involvement in activities related to math achievement. Their study revealed a positive relationship between math achievement and community partnerships that allowed for practice of skills learned in school. This claim was generally supported by Dumais (2006), where extracurricular activities were shown to be

beneficial in improving academic achievement. The effects of extracurricular activities were also extended to improve academic outcomes of ethnic minorities and students with low SES. On a closer examination of the results produced by Dumais (2006), the extracurricular activities that involved arithmetic skills such as music did not have significant impact on math achievement. Although there has not been previous research on the effects of math related extracurricular activities and its effects on math achievement, Papanastoasiou and Bottiger (2004) conducted a case study on the effects of a math club. The authors suggested that a math club at the middle school level increased opportunities to do math as well as awareness in math. The results of the study suggested that math clubs promote a positive attitude towards math and are associated in encouraging students to attain and pursue math related goals and careers (Papanastoasiou & Bottiger, 2004). This finding is significant as it showed the participation of extracurricular activities involving math (i.e., Math club, Mathlete) would directly affect students' math achievement.

In summary, there are three themes that are dominant and heavily expected to affect math achievement, including: *demographic factors, personality attitude factors and community and extraneous support*. The present study was designed to investigate for those themes in Saskatchewan students. Specifically, the current study examined whether the gender gap existed with Saskatchewan students, and if so, where the gap lies. In addition, the current study examined differences between rural and urban student achievement to investigate whether previous findings about rural schooling still stand now. From the studies highlighted above, it is evident that the level of confidence in math is a complex relation and does not relate simply to a positive outcome in math achievement. This is contradictory to findings from classical research in math achievement, where the level of confidence was dependent on the level of math

achievement. Lastly, the present study explored the extent to which personal attitude factors such as confidence and locus of control had an effect on Saskatchewan students' math achievement, and if so, whether that effect has a negative or positive impact on math achievement.

Current Study

The current study employed exploratory factor analysis to first identify common themes in the student questionnaire. Then using results from the AFL Math Assessment program collected in 2007, a regression analysis determined the level of relation that the common themes have with math achievement scores.

Hypotheses

Given the level of literature reviewed as justified in above sections, the following hypotheses were formulated in order to address the research questions stated in Chapter One:

H1a: There will be factors that are identifiable in relation to math achievement.

H1b: The factors will be related to the themes that have emerged from the previous review of math achievement models.

H2: The factors will have a significant relationship in affecting math achievement from the AFL results tested.

H3: There will be no significant differences in mathematics achievement due to differences of school location or gender.

Chapter Three

Methodology

The following chapter outlines the methods used in the current study. The chapter restated the purpose of the analysis, and addressed the sampling population and the demographics information. Questions used and responded to by the sample population were discussed in the instrumentation section. The design of the study was explained, followed by a short explanation of the methods used for data analyses. Lastly, ethical considerations were discussed.

Research Questions

The present study is designed to investigate the following issues:

1. Are there identifiable factors amongst students in Saskatchewan that may affect academic achievement in math? If so, what are the factors?
2. Can student questionnaire responses, such as the ones designed according to OTL, be used to evaluate math achievement differences across Saskatchewan?
3. Does school location or student gender have a significant effect on math achievement differences?

In order to measure math achievement among students in Saskatchewan, results from the 2007 mathematics assessment for learning program were used as a measure of math achievement.

Sampling

The current study is a secondary data analysis which utilized data that had been previously collected for the provincial mathematics assessment program in 2007. The sample population of the dataset was selected using a non-random, purposive sampling technique.

Specifically, the study included students that were studying under the Saskatchewan curriculum (i.e., excludes federally funded schools) in Saskatchewan that have participated in the Mathematics Assessment Program. In total, 11,279 grade five students participated in the assessment. All grade five students in the province were required to participate in the assessment. Such information as the socioeconomic status or family demographic information was not collected. However, the relatively large sample size should produce generalizable results for all students studying within the education system in Saskatchewan.

The students were administered the assessment province-wide within a two-week period in late May 2007. The tests were completed school-wide in two days during class time with three hours allotted between the two days to complete the entire assessment. Upon completion of the mathematics assessment, students were asked to complete the student questionnaires for supplementary information. All students were required to complete the assessment unless they could provide a written notice for medical exclusions. No information was provided for the criterion for which students with special needs had to complete the assessment.

Instrumentation

The design of the current study was based on studies that attempted to investigate factors affecting math achievement as discussed in previous chapters (Ethington, 1992; Joshi, 1998; Kopsoyich, 2001). The current section discusses the variables used in the current study as well as the survey and tests that were administered to students for the analysis of this study.

Student Questionnaire

The questions used as the exogenous or explanatory variables in the current study were designed by Saskatchewan Learning. The questionnaires were administered to students following their math assessments. The questionnaire consisted of 100 questions that probed the students'

learning habits and feelings towards math learning (see Appendix 1). The questionnaire was designed by Saskatchewan Learning based on the models of Opportunity-to-Learn (OTL; Saskatchewan Learning, 2000 a, 2000b). The OTL model was originally designed to report for three themes with students for the math assessment: Readiness, Persistence and Parental Support (Saskatchewan Learning, 2000 c). Although some of the questions were devised based on student questionnaires used by SAIP and PISA, no specific psychometric evidence or reasoning was built into the construction process as the questionnaire was not designed as a research instrument (Saskatchewan Learning, 2000 b). However, there were a few questions created with background information; hence those questions from the questionnaire were placed in a subset of questions to investigate students for possible factors in the current study. The current study used a subset of 17 question responses from the questionnaire because the questions had been used and demonstrated reliability on other learning factors identified within the SAIP program (SAIP, 2003). The list of the subset questions along with their supporting references in other assessment programs are listed in Table 4. It should be noted that the questions used in the subset were renamed with the suggested factors as a prefix for easier identification during factor analysis. The instructions for the questionnaire addressed anonymity of the information and encouraged students to attempt to complete the questionnaire in its entirety.

After the responses to the questionnaire were collected, the responses were appropriately dummy coded for the respective responses along with changing letter-coded variables into binary coded variables. Missing data were appropriately coded for the Statistical Package for Social Sciences (SPSS, 2006), the data analysis software used in the study. Other multivariate data cleaning efforts were used and are discussed in later sections. The results of the questionnaire

were combined with students' respective math assessment results using a unique identifier for each participant.

Table 4

Items in the Subset from the Students Questionnaire administered with the Assessment for Learning Program in 2007

| Variable Name | Question wording | Related References |
|--|--|-----------------------|
| Locus of control towards Math Achievement(LQ) | | |
| LQ8 | Do you learn mathematics most easily when you... | Chart 89; SAIP(2003) |
| LQ9 | To do well in mathematics at school, which is most important? | Chart 90; SAIP(2003) |
| Confidence towards Math(CQ) | | |
| CQ6 | What do you think of the statement: "I like mathematics"? | Chart 98, SAIP(2003) |
| CQ7 | What do you think of the statement: "I feel confident when I do mathematics questions"? | p. 92, SAIP(2003) |
| CQ171 | Math is easy to understand | p. 91, SAIP(2003) |
| CQ1720 | I feel confident talking about how math is used in real life. | Chart 85, SAIP(2003) |
| CQ1723 | I feel confident learning math. | p.54, SAIP (2003) |
| CQ1729 | I like mathematics. | p.54, SAIP (2003) |
| Parental and Extra-curricular Help(PQ) | | |
| PQ201 | They are interested in how I am doing at school. | p.56, SAIP (2003) |
| PQ2012 | They ask me questions about math and encourage me to find answers. | p. 56, SAIP (2003) |
| PQ2013 | They like to help me or work with me when I am doing my math homework. | Chart 87, SAIP (2003) |
| PQ2015 | When they help me with math homework, they make sure I understand it. | Chart 103, SAIP(2003) |
| PQ2017 | They help me learn math. | p.57, SAIP (2003) |
| PQ21 | Are you happy with how well your family supports your learning? | Chart 18, SAIP (2003) |
| Extra-curricular Involvement in Math(OQ) | | p. 92, SAIP(2003) |
| OQ1817 | I try to figure out how the math I learn in class might be useful in the real world or in my other subjects. | p. 80, SAIP(2003) |
| OQ1819 | When I am having trouble with a hard math problem, I use the internet to help me solve it. | Chart 51, SAIP(2003) |
| OQ 19 | How often do you do your own math activities or projects outside of class time (just for fun)? | p.80, SAIP(2003) |

Mathematics Assessment

The 2007 mathematics assessment program devised by the Assessment for Learning department was designed in collaboration with Saskatchewan Learning in consultation with practicing teachers. The assessment was designed with four sections: Math Proof, Calculator Use, Multiple Choice, and Computer Use. The current study used only the results from the Multiple Choice section. The assessment was administered to grade five students with the same administration procedures as mentioned in the questionnaire section; a total of 40 multiple choice questions were administered in both tests. Each question given in the multiple choice section is referenced to a specific learning objective listed in the curriculum guide for the specific grade. Each question can be placed into a sub-category of learning objectives. The categories of learning objectives and the number of questions dedicated to the respective categories were previously presented in Table 1. See Appendix 2 for the questions used in the math assessment.

The scores of the math assessment were tabulated in the following manner. Each correct multiple choice response would earn a point. The points are represented in two ways: (a) a total of all correct responses and (b) a set of subsection scores tabulated by correct responses within each learning objective. The current study uses both scores to determine any specific differences in factors affecting math achievement according to a specific learning objective. Although the scores of the test were originally designed under the criterion referenced model, the test results were not released to the public on an individual basis, and the results of the assessment are used for curriculum development purposes. The results of the math assessments represent the consequent (dependent) variables in the proposed model.

The following section first discusses the validity and reliability evidence in the Math Assessment (the multiple choice section), followed by the student questionnaire. There has been

minimal validity information published on the construction methods of the assessment, so the present study attempts to describe evidence for information that was not provided by AFL.

The following section is a description of the content validity, which is the ability of test questions that can represent the math skills the students should have attained in their respective grade (Cronbach & Meehl, 1955). All questions within the math assessment have a reference to the relevant learning objectives as listed in the curriculum. In addition, 48 randomly selected teachers were involved for standard setting to provide for content and construct validity improvements (Saskatchewan Learning, 2008).

Criterion validity, the ability that test questions would reflect on other types of test (Cronbach & Meehl, 1955), has not been demonstrated. This type of validity may not be necessary for the assessment design process with Saskatchewan Learning as the Ministry is only interested in finding learning differences among Saskatchewan students.

Evidence for content validity is to demonstrate that the content of the assessment is testing the material being instructed. The AFL assessment demonstrates such evidence in the design of the assessment. The content of the assessment was derived directly from the learning objectives as stated in the provincial mathematics curriculum with each item tested referenced back to the specific learning objective in the curriculum (Saskatchewan Learning, 2008). The above design should provide sufficient evidence that content validity of the assessment is met. No other large scale math assessment instrument exists for evaluating the Saskatchewan curriculum. Therefore, convergent validity cannot be demonstrated.

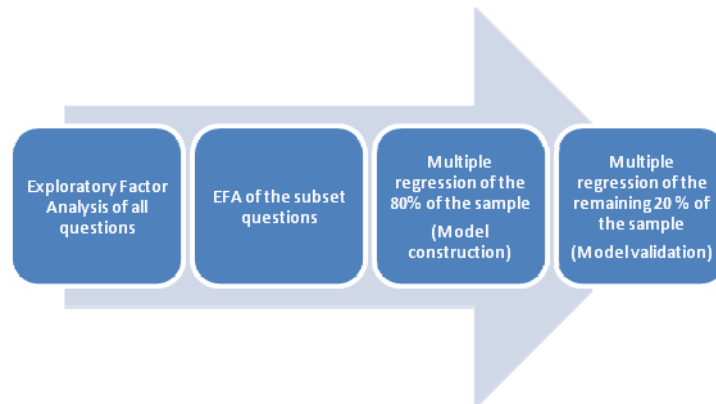
For the purpose of reliability, the question responses were examined using Coefficient Alpha (α) to test for internal consistency to ensure the reliability of the responses to be represented as a measure of math achievement. Dunnally(1978) suggested for a threshold of $\alpha >$

.7 as evidence for internal consistency in a scale. In contrast, the questions posed in the student questionnaire were not created based on any type of reliability or validity evidence.

Proposed Design

In order to address the research questions as listed and to confirm the model of math achievement for students in Saskatchewan, the present study was conducted in two phases. The analysis procedure is depicted in *Figure 5*. The first phase of the study addressed whether there were common factors *within* the student questionnaire responses. To investigate the possible relationship, a set of factor analyses was completed on two sets of responses. The first iteration attempted to factor-analyze all 100 responses of the student questionnaire in attempts to find common themes. A second iteration of the factor analysis was comprised of 20 questions that have been previously used and suggested to probe certain aspects by other assessment programs. The purpose of conducting a series of exploratory factor analyses was to confirm their expected relationships amongst the grade five student responses in Saskatchewan. If the questions did prove to cluster in groups as predicted, they would suggest the existence of learning factors among elementary students in Saskatchewan. After the student questionnaire responses were explored for the possibility of factors, the second phase of the analysis explored how the questions and factors affected math achievement. The first phase of the study was used to demonstrate the existence of the model, which would allow for the use of regression modeling in the next stage.

Figure 5 Figure Showing the Design of the Present Study



The second phase of the analysis was devised to determine the relationship *between* math achievement and factors suggested by the first phase of the study; using stepwise multiple regression as the prediction method. The benefit of using regression analysis was to allow univariate interpretation of the questions that affected math achievement. Multiple predictor variables such as the questionnaire responses could be analyzed for their effects with the students' math assessment scores. To prevent the model from over-fitting the sample given, cross-validation methods were employed to ensure model consistency. If the questions are effective in influencing math achievement, they should prove to be a significant variable in the regression model. Lastly, in order to test significant differences between demographic categories as listed in research question 3, the use of Multivariate Analysis of Variance (MANOVA) was used to determine differences in math achievement across demographic categories.

Data Analysis

Exploratory factor analysis (EFA) is a method used in behavioural and social sciences research to reduce the number of variables into smaller subsets by analyzing and clustering similarly responded variables (DiIorio, 2005). The key feature of EFA is to allow the

identification of latent variables, variables that are not measurable and indirectly relate the measurable to the explanatory variable. An alternative analogy of a latent variable could be thought of as the overarching theme that represents measurable or predictor variables that tend to correlate well together (DiIorio, 2005). To determine whether an EFA model fits or if the factor extraction is useful, the given eigenvalues and percentage of variance accounted for can be used to determine fitness factor modeling.

The Kaiser-Guttman rule, the most commonly used criterion for factor extraction (DiIorio, 2005), suggests the extraction of any factors that have an eigenvalue above 1.0. Since the eigenvalue is determined from the pool variances accounted for by the suggested factor, the Kaiser-Guttman rule can be argued to be over or under-estimating the number of factors to retain, as the pooled variances do not necessarily reflect the level of correlation within the factor and between factors (Tabachnick & Fidell, 2006).

The interpretation of the scree plot produced from eigenvalues of the factors is an alternative method for factor extraction. An analysis of the screeplot suggests that any factors deviating from the slope originating from the least significant factor (lowest eigenvalue) are considered significant (Tabachnick & Fidell, 2006). The analysis of the screeplot is often the initial analysis within a factor analysis. Although it is not very statistically sound, combined use of the screeplot and Kaiser-Guttman offers complimenting evidence to differentiate and identify significant factors.

There are different methods of conducting EFA, the present study has chosen the method of principle component analysis (PCA) as the method for EFA. The PCA is somewhat different from other EFA methods, where PCA analyzes for communalities between factors as it is used to account for common variances (DiIorio, 2005). Other EFA methods, such as maximum

likelihood estimation or principle axis analysis, have a more stringent procedure in grouping correlated variables by accounting for unique variances within each factor in contrast to common variances in PCA. The use of PCA is to identify common factors among the student questionnaire responses and group the questions that elicited for a similar pattern of responses together. Since the sample size of the study is large, with over 5000 grade five students after list-wise deletion of missing data, the use of any EFA methods was suitable for reporting (Tabachnick & Fidell, 2006). The use of Kaiser-Guttman and screeplot was used for factor extraction from the PCA. Assumptions of the PCA were tested, but with the relatively large sample size, the key assumption of skewness was not likely to be violated.

Factor analysis can be difficult to interpret depending on how the questions are clustered together and where the perceived latent factor is thought to be. The availability of rotation methods simplifies the interpretation of factors by allowing the rotation of the axis of the theoretical factors to allow a more accurate depiction of the themes represented. The two rotational types most commonly used can be separated into orthogonal or non-orthogonal. An orthogonal rotation assumes latent variables or factors to be unrelated to each other. This would allow easier interpretation of unrelated factors in a clearer manner, but it would not be a fitting rotational method for extracted factors that may be related to each other. The non-orthogonal rotation (oblique) methods are beneficial for interpretation of latent variables that may be closely related to each other. Non-orthogonal rotation would allow better interpretation of highly related latent proposed factors, but the interpretation of the factors would have to be carefully considered due to a higher possibility of misrepresentation of measured variables or variables related to a different factor.

In the second phase of the analysis, multiple regression (MR) was used as the method of analysis to investigate the relationship between the student questionnaire responses and math achievement results. The present study used results of the EFA to create categories of scores according to the suggested factors and used them as dependent variables in the MR. To do so, scores for the items belonging to each factor were summed to create a new score to represent the factor. Coefficient alpha was calculated for items within each factor to account for internal consistency. The current study incorporated a cross-validation design, where two regression models were tested to ensure the model was reliable and to prevent over-fitting of the model. Tabachnick & Fidell (2006) suggested that the dataset should be divided into an 80-20 percent split for cross-validation models, such that the results from a smaller portion of the sample will be used to validate the model created from the majority of the sample. The first regression model was constructed from 80% of the sample using random selection. The results were placed in the MR using the stepwise entry method at an entry requirement of $p < .05$ and rejection requirement of $p > .10$. In addition, the second regression model is created from the remaining 20% of the students results to see whether the first model will hold using the remaining sample. Significance of the second model was reported as the test of significance to see whether the first regression model would hold. In order to ensure that multivariate assumptions were met, multivariate data cleaning was completed before data analyses.

Multivariate Data Cleaning

Descriptive analysis was conducted for the purpose of data cleaning, to examine the general tendency of data, and for the purpose of data cleaning. Individual descriptions of the variables were examined to check for skewness of all individual measures. Furthermore, the dataset was cleaned of erroneous variables and re-categorized into missing variables. Test of

Mahalanobis distance was completed for outliers, and a correlation matrix was developed to examine multicollinearity (Tabachnick & Fidell, 2006). The dataset was cleared of missing values to increase power to the model, an assumption of multivariate analysis (Tabachnick & Fidell, 2006). The method of case-wise deletion was used in dealing with missing values. The case-wise (or list-wise in SPSS) deletion exempts the sample selection with the missing data from the analysis, as it takes the entire sample (case) out of analysis. The case-wise method was beneficial for maintaining an analysis with no missing data, but if missing data were sporadic and highly evident in the dataset, the use of case wise deletion would result in a low sample size hence threatening the power of the study.

In addition to multivariate data cleaning, the present study also utilized correlation tables and coefficient alpha methods to ensure reliability in the assessment results to confirm for their respective categories. The following section discusses the ethical concerns for the study.

Ethics

The information used in the current study was kept confidential and met the ethical demands according to the information release act from Saskatchewan Learning. No individual records were used for comparison, nor was the overall performance of the assessment discussed. The present study focused on the factors that affect math achievement and how significant an effect would have on math achievement. In addition, information regarding specific schools or boards was not discussed. The use of information that could potentially be individually identifiable was destroyed. An ethics proposal was submitted and ethical approval was exempted from the present study, see Appendix 4 for details.

The current chapter discussed the methodology and explanation of the procedures to conduct the current study. All aspects and specification of the study were outlined. The next

section begins the explanation of the research data and the results of the analyses conducted in the study.

Chapter 4

Results

The purpose of this chapter is to present the results of the data analysis. The results of the study are presented in the order of the research questions. In addition, descriptive statistics regarding student demographics are presented.

The study included students enrolled in grade five in the public education system in Saskatchewan; their demographic information is presented in Table 5. Only a limited amount of demographic information was collected from the students in the student opinions survey, as the Ministry considered detailed student information was unnecessary for their analysis. The results revealed that 48.9% of the students who participated were male and 47.4% were female; 41.7% of the students lived in a rural environment, and 57% of the students were from schools in an urban environment. As well, information was collected to indicate whether the students had identified themselves to be aboriginal descendents. Approximately one third (36.1%) of grade five students had identified themselves as aboriginal descendents.

Table 5

Student demographics in AFL Math Assessment Program for 2007

| Demographics | N | Percentage |
|--------------|--------|------------|
| Location | | |
| Rural | | |
| Male | 2,300 | 20.39% |
| Female | 2,242 | 19.88% |
| Rural Total | 4,542 | 40.27% |
| Urban | | |
| Male | 3,158 | 28.00% |
| Female | 3,024 | 26.81% |
| Urban Total | 6,182 | 54.81% |
| Missing | 555 | 4.92% |
| N | 11,279 | 100.00% |

The multiple choice section of the AFL math assessment was used as a measure of math achievement for this study. The multiple choice section, comprised of 40 questions, was derived from five learning categories: *Whole number operations*, *Fractions*, *Geometry*, *Measurement* and *Data Analysis*, where each correct response to a question would correspond to a point. A description of the assessment results is presented in Table 6. The maximum score is the highest possible number of correct responses a student can achieve. Means and standard deviations of categorical scores suggest that the distribution of scores are normally distributed, independent of confounding factors, and do not exhibit any ceiling or floor effect; all of which were assumptions for the data analyses used in this study. Furthermore, the study has avoided further discussion of the assessment scores (i.e., how the students were scored in each category, whether the students did well) due to the complex and sensitive nature of the results. Instead, the study used the variances of the math scores with the grade five students as a dependent variable to determine

how math achievement varies according to student questionnaire responses. It should be noted that the grasp of each student in each category is not consistent, this is exhibited by the score differences between *Whole Numbers* and *Fractions*. While *Whole Numbers* had one fewer question than *Fractions*, fractions had a lower mean than *Whole Numbers*. The difference of means suggests students' grasp of *Fractions*, according to the Ministry's curriculum, was weaker than their grasp with *Whole Numbers*. Otherwise, the categories of learning correlated well with each other, as the coefficient alpha for the five categories was high ($\alpha = .82$). This high correlation provided evidence for internal consistency to show that the assessment results from each category can be represented as a single measure to represent students' math achievements.

Table 6

Descriptive statistics of the AFL Math Assessment scores for grade five students in 2007

| Variable s | Minimum | Maximum | Mean | Std Dev |
|---------------|---------|---------|-------|---------|
| Whole Numbers | 0 | 11 | 6.55 | 2.59 |
| Fractions | 0 | 12 | 5.79 | 2.55 |
| Geometry | 0 | 5 | 2.84 | 1.30 |
| Measurement | 0 | 7 | 4.4 | 1.67 |
| Data Analysis | 0 | 5 | 3.17 | 1.24 |
| Total Score | 0 | 40 | 22.74 | 7.49 |

$$r^2 = .821$$

Data Cleaning and Correlations

Mahalanobis distance is a method of analysis used to determine the independence of the multivariate data from an unknown mean and to identify outliers in the data (Tabachnick &

Fidell, 2006). The purpose of using Mahalanobis distance was to ensure that the dataset is representative of the sample. For example, if there are too many outliers in a given sample, it would suggest the sample response may be too scattered, which suggest the existence of confounding variables outside of the variables used in the analysis. In this study, the findings have a mean Mahalanobis Distance of $M = 24.00$, $SD = 9.3$, and a total of 130 outliers were identified in the sample, accounting for 1.5% of the entire dataset. These results demonstrated that there were no significant influential observations in the dataset, therefore suggesting the dataset was representative of the population. Univariate tests of outliers using leverage values have yielded no outliers in this study, where the largest leverage value ($h=.0054$) from the sample did not exceed the maximum calculated leverage value ($h<.0057$; Tabachnick & Fidell, 2006). The results of the leverage values suggested that there were no significant outliers in the multiple regression model tested in this study.

Correlations among responses were calculated for reliability purposes (see *Appendix 3*). However, the inter-item correlation did not reveal any extremely high or extremely low correlated responses that would be considered redundant if both items were included. The use of list-wise deletion was used in all cases to eliminate respondents with missing values. This freedom of removing cases with missing values was allowed as it was not problematic for the effect size because the sample size was well over 5000 for all analyses completed. Further data manipulations were completed to better accommodate the data. Specifically, two questions (LQ8 and LQ9) were recoded to reflect the changes of attribution as previously identified and used in SAIP. In addition, questions 20-1 and 20-15 were reverse coded because the wording of the questions was negatively phrased compared to other questions. The individual questions and the

possible responses are presented in Appendix 1. The following sections explain the results of the study in the order of the research questions posed.

Research Question 1:

Are there identifiable factors amongst students in Saskatchewan that may affect academic achievement in math? If so, what are the factors?

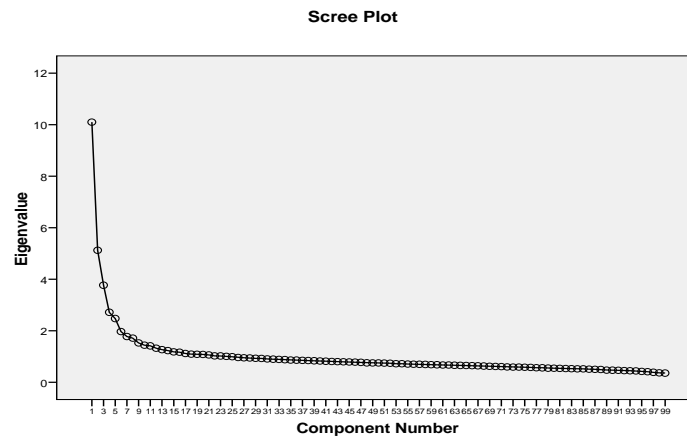
To respond to the first research question, a set of exploratory factor analyses were completed to determine if there were grouped responses that suggested a trend of factors. First, an EFA was conducted on all one hundred items from the student questionnaire (see Appendix 4). One criterion used for extracting a factor was an eigenvalue greater than one (Tabachnick & Fidell, 2006). A scree plot was also used to help determine the number of extracted factors. An item was considered to fit a factor when the factor loading value is greater than .32 (Tabachnick & Fidell, 2006). The value of .32 was used because it accounts for approximately 10% of the variance in the responses. This technique is prevalent in EFA factor extraction (Comrey & Lee, 1992).

The results of the principal component analysis produced a non-rotated factor solution that was very similar to the rotated factor solution, therefore rotated solutions were displayed to ease the interpretation of factors. The non-orthogonally rotated factor solution was not significantly different from the orthogonally rotated solution, suggesting that non-orthogonal rotation was not necessary in this case. Thus, only the orthogonally rotated factor matrix is displayed in Appendix 4. The results of the factor analysis showed positive support for the idea that some of the question responses may be related to one another. The scree plot suggested the existence of 6 to 7 factors (See *Figure 6*) for the 100 items, but the Kaiser-Guttman method of

extraction suggested the existence of 24 factors accounting for 49.2% of total variance. The abundance of factors extracted was extremely difficult to interpret.

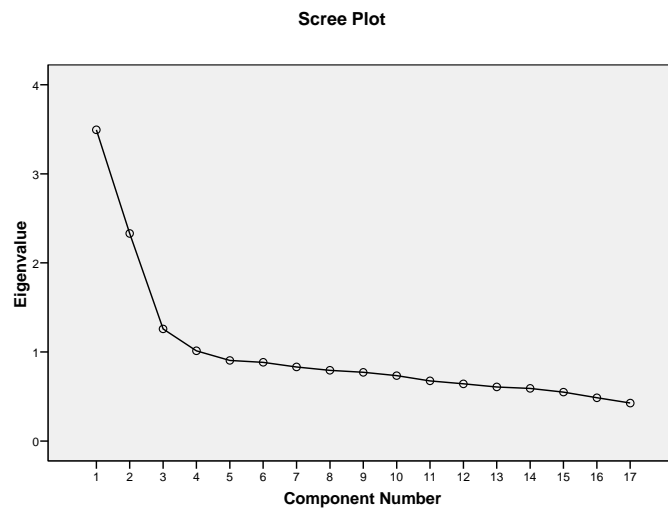
The discrepancy between the results of different extraction methods and the difficulty in interpreting a 24 factor solution prompted the need to examine a smaller subset of questions. The use of a subset that has been previously supported by other assessment programs may be beneficial in this case as the subset items had already been suggested to relate to certain factors. If the questions had a similar pattern of responses, then they should suggest that students in Saskatchewan have the same learning style differences.

Figure 6. Scree plot of the PCA results with all items in the student questionnaire.



The items for the subset, presented in Table 4, and the use of PCA on the subset of questions, yielded favourable results for the existence of affective factors in Saskatchewan students' learning. The extraction of factors was based on the consensus of the scree plot results and the Kaiser-Guttman rule for factor extraction (DiIorio, 2005). Based on the Kaiser-Guttman method, there were four suggested factors to be extracted. In contrast, the results of the scree plot suggested the existence of three possible factors (see *Figure 7*), as there were only three distinct points that differed from the slope originated from the right hand side of the graph.

Figure 7. Chart showing scree plot results from PCA of subset items.



The four distinct factors were then rotated using an orthogonal rotation method (varimax), which allowed for a more even distribution of variances across all factors. The factors extracted accounted for 47.2% of the variances from the questions, and were also supportive for three of the four factors used in the subset. The suggested factors were: *confidence in math*, *extra-curricular involvement in math* and *parental involvement in math*. The items belonging to *locus of control* category were seen to be insignificant (see Table 7). The reasons that the fourth factor was eliminated were: (a) the discrepancy between the results of the scree plot and Kaiser-Guttman method, and (b) the fourth suggested factor only had one item that was significantly loaded on the factor. The significant loading on only one item was important as the minimum of two items was needed to represent a factor (Comrey & Lee, 1992).

Table 7

The PCA results of the 17 item subset from the student questionnaire responses.

| Questions | 1 | 2 | 3 | 4 |
|------------------------|-------|--------|-------|-------|
| CQ6 | 0.721 | | | |
| CQ7 | 0.655 | | | |
| LQ8 | | | | |
| LQ9 | | | | 0.937 |
| CQ17-1 | 0.657 | | | |
| CQ17-20 | 0.463 | | | |
| CQ17-23 | 0.683 | | | |
| CQ17-29 | 0.723 | | | |
| OQ18-17 | | | 0.563 | |
| OQ18-19 | | | 0.642 | |
| OQ19 | | | 0.534 | |
| PQ20-1 | | 0.553 | | |
| PQ20-12 | | 0.631 | | |
| PQ20-13 | | 0.706 | | |
| PQ20-15 | | 0.740 | | |
| PQ20-17 | | 0.766 | | |
| PQ21 | | 0.469 | | |
| Eigenvalue | 3.018 | 2.655 | 1.384 | 1.041 |
| Percentage of variance | 17.75 | 15.617 | 8.139 | 6.125 |

The results of the PCA showed favourable results for the three extracted factors (*confidence in math, extra-curricular involvement in math, and parental involvement in math*), as there were no cross loaded items and all but one item loaded onto the expected factors. The weakest loading was .463 in question 21 (PQ21), which was considered a fair fit (Comrey & Lee, 1992). The remaining factors were considered to be either good ($> .55$), very good ($> .63$) or excellent fit ($> .7$) (Comrey & Lee, 1992), with the majority of the loading greater than .63. All items were determined to belong in the same concept and were shown to load within the expected factor.

The factors identified in the PCA relied on common variances that the items contributed towards the overarching concept (DiIorio, 2005). The most variances accounted for by a factor were within *confidence in math* items, where 17.75% of the variance from the response was accounted for by the questions belonging to that factor. The least variances accounted-for by a successfully extracted factor were within the *extracurricular involvement in math* items, with 8.14% of the total variances accounted for. The percentages of variances accounted-for suggest how strongly each factor is represented by their respective items. In the two values presented above, it suggests the items used in the *confidence in math* factor were stronger in representing the factor than items used in *extracurricular involvement in math*.

In summary, the results of the PCA suggested that there was evidence to support the existence of learning styles as previously identified. Those possible factors are: *confidence in math*, *extra-curricular activities involving math*, and *parental involvement in math*. Items for *locus of control* did not show significance to be represented as a factor. The identified factors were used to predict for math achievement in the next phase of research, and the interpretation of these possible factors is discussed in a later chapter.

Research Question 2

Can student questionnaire responses, such as the ones designed according to OTL, be used to evaluate math achievement differences across Saskatchewan?

From the results of the EFA, three possible factors were identified from the grouping of the question responses. To allow for the analysis of the factors in the next step of the analysis, results in the respective factors were grouped and summed to create a unique score for each factor. Coefficient Alphas (α) were calculated for items within each factor to ensure that the

items represented in the new factor scores had evidence of internal consistency. Nunnally (1978) suggested an alpha value of .7 or greater to be an acceptable threshold for internal consistency; this criterion was not met for new factor possible OQ ($\alpha = .336$). The repercussion for this low internal consistency is discussed in the later section. Information regarding the newly created factor scores is presented in Table 8.

Table 8

New scores created from the results of the PCA solution.

| Proposed Factor Names | Min | Max | Mean | SD | α | Items |
|--|-----|-----|-------|------|----------|--|
| Confidence in math(CQ) | 2 | 12 | 8.18 | 2.42 | 0.736 | CQ6 CQ7 CQ17-1 CQ17-20 CQ17-23 CQ17-29 |
| Parental involvement in math(PQ) | 6 | 24 | 10.32 | 3.42 | 0.739 | PQ20-1 PQ20-12 PQ20-13 PQ20-15 PQ20-17 PQ21 |
| Extra-curricular involvement in math(OQ) | 3 | 13 | 9.50 | 2.08 | 0.336 | OQ18-17 OQ18-19 OQ19 |

In order to explore whether the three possible factors were related to student math achievement, a multiple regression was used to determine the predictive abilities of those factor scores and student demographic information. Forty multiple choice items (See Appendix 2) from the 2007 AFL math assessment were used to represent student math achievement (dependent variable). Student gender and student school locations were used to predict for math scores

(independent variables), along with scores from three suggested factors. A list-wise deletion for cases with missing data was employed yielding a sample of 8,468 students. The sample was split randomly into 80% - 20% sections to allow for cross validation of the constructed model.

The result of the first model was created from 80% of the student responses (see Table 9). The regression was significantly different from zero, $F(5, 6907) = 126.49, p < .001$, with the model accounting for 8.4% of total variance. All predictors with the exception of *parental involvement* in math (PQ) were shown to be significant in predicting math achievement for grade five students in Saskatchewan, with PQ approaching significance ($t(6907) = -1.929, p = .054$).

Table 9

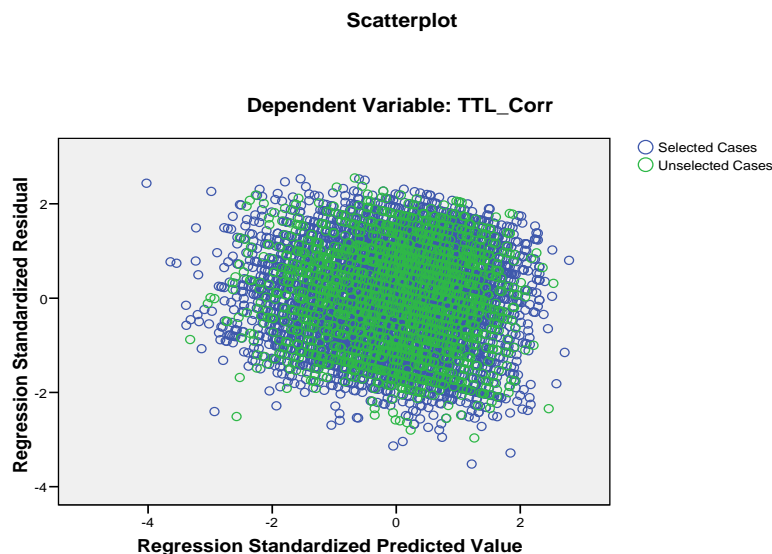
Variables used in a regression model in predicting math achievement

| Model | B | Std. Error | t-test | Sig. |
|--------------|--------|------------|--------|-------|
| Constant | 13.608 | 0.758 | 17.962 | 0.001 |
| Location | -0.978 | 0.172 | -5.681 | 0.001 |
| Gender | -0.377 | 0.171 | -2.200 | 0.028 |
| CQ | 0.874 | 0.037 | 23.362 | 0.001 |
| PQ | -0.050 | 0.026 | -1.929 | 0.054 |
| OQ | 0.537 | 0.044 | 12.178 | 0.001 |
| $r^2 = .084$ | | | | |

The second regression model was constructed from the remaining 20% of the sample to provide evidence of cross validation for the first planned model. With a sample size of 1,729, the model was significant ($F(5, 1724) = 22.92, p < .001$), but accounted for less variance than the original model ($r^2 = .063$). There were two factors that failed to remain significant in the second

model (*location of school* and PQ; $p > .05$), but the low variable coefficients and the reduction in sample size may have attributed to their lack of significance. The use of scatter plots demonstrated an independent distribution of the actual scores within the predicted values (See *Figure 8*). Overall, case-wise diagnostics and Cook's distances have yielded only six cases of outliers in the entire sample set.

Figure 8. Scatterplot showing distribution of predicted scores with the observed score in the original model.



Although the regression model created with the factors was statistically significant, there were issues with validity for using factor scores to predict math achievement. This is in addition to the low level of variance included in the regression model, along with the low internal consistency reliability with the factors created. In order to correct for the low internal consistency, factor scores were eliminated in favour of individual items scores. The individual

items were taken from the items belonging to factors used in the first regression. A modified regression model was conducted with the 15 items that contributed to the three factors (instead of using the summed factor scores) and the same two demographic categories. To ensure that all individual items would be statistically significant in predicting math achievement, a stepwise selection method was used to exclude items that were insignificant ($p > .05$). A cross-validation design similar to the first regression model was devised in this modified regression model.

The modified regression model was created with 80% of the student responses chosen at random. The model was statistically significant in predicting math achievement ($F(13, 6768) = 78.46, p < .001$), and included 11 of the 15 items from the three expected factors (4 of 6 items from CQ, 5 of 6 items from PQ and 2 of 3 items from OQ, see Table 10) in addition to the two demographic categories (*gender* and *school location*). The modified model accounted for 12.4% of the total variance created by the multiple-choice section of the AFL math assessment.

Table 10

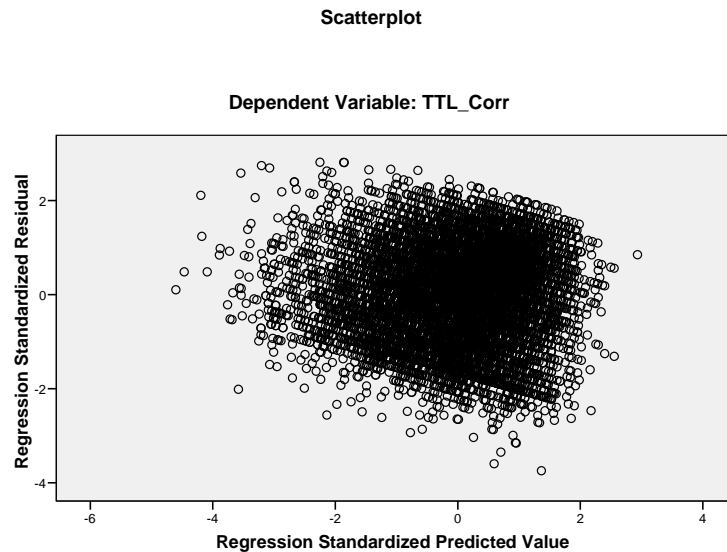
Variables used in a modified regression model using individual item responses

| Model | B | Std. Error | t-test | Sig. |
|------------|--------|---------------|---------|-------|
| Constant | 12.927 | 0.773 | 16.714 | 0.001 |
| Gender | -0.577 | 0.170 | -3.390 | 0.001 |
| Location | -0.719 | 0.171 | -4.214 | 0.001 |
| CQ7 | 1.366 | 0.130 | 10.518 | 0.001 |
| CQ17-1 | 1.371 | 0.206 | 6.658 | 0.001 |
| CQ17-23 | 1.090 | 0.213 | 5.128 | 0.001 |
| CQ17-29 | 0.754 | 0.198 | 3.811 | 0.001 |
| OQ18-17 | 0.574 | 0.088 | 6.523 | 0.001 |
| OQ18-19 | 1.528 | 0.127 | 12.077 | 0.001 |
| PQ20-1 | -1.483 | 0.133 | -11.161 | 0.001 |
| PQ20-12 | 0.259 | 0.097 | 2.664 | 0.008 |
| PQ20-13 | 0.359 | 0.101 | 3.571 | 0.001 |
| PQ20-15 | -0.491 | 0.124 | -3.977 | 0.001 |
| PQ20-17 | 0.372 | 0.117 | 3.170 | 0.002 |
| $r^2=.124$ | | | | |

The most influential item in the modified regression model was question number 7 (CQ7) regarding *confidence in math*. The response scale for that question was a four-point continuous scale with a variable coefficient of 1.366 (indicating that the response of that question could account for a fluctuation by approximately four correct responses in the math assessment out of the possible 40 questions). Although there were other factors that were higher in coefficient values, they were limited to a binary scale (1 or 0, with no additional multiplier). Cross

validation using 20% of the sample ($n = 1,963$) showed statistical significance in the modified model ($F(13, 1950) = 22.09, p < .001$, see *Figure 9* for a graph of the actual vs. predicted distribution), but four of the 13 items in the modified model were not statistically significant (CQ17-23, CQ17-29, PQ20-12, PQ20-17; $p > .05$). This lack of consistency in significance suggested that the math achievement trend predicted by the items individually was not statistically robust. From this deduction and the findings of the original regression model, it can be concluded that math achievement cannot be accurately predicted by the factors suggested. While there was evidence to suggest that learning trends were available and could possibly account for math achievement, the lack of consistency in the factor scores and the lack of robustness in the individual item results demonstrated the irritability of predicting math achievement using these measures. The implications and explanations of these findings are discussed in the next chapter.

Figure 9. Scatterplot showing distribution of predicted scores with observed scores in the modified model.



Research Question 3

Does school location or student gender have a significant effect on math achievement differences?

Multivariate Analysis of Variance (MANOVA) was used to investigate whether there were any significant differences in math achievement across different demographic groups of the population. Specifically, the two groups used were *school locations* (rural and urban) and student *gender*. The dependent variables used to represent measures of math achievement were separated by the five learning objective categories in order to provide for a more specific prediction across different levels of achievement. The categories were designed and assigned by Saskatchewan curriculum (Saskatchewan Learning, 2007a). The summary of the respondents belonging to each

group was outlined in the descriptive table (see Table 5), and the categories of learning and number of questions were also reported (see Table 4).

The results of the MANOVA were significant across both school location and gender categories. The Box's M test for equal variance across groups was significant, which meant the assumption of homoscedascity could not be assumed. This assumption was expected because the independent variables were categorical and had a different number of respondents in each group. Since equal covariance across groups cannot be assumed, the Pillai's Trace method was used to test for the differences. The assumption of normality is assumed to be valid from the large sample size and the test of outliers was conducted with the Mahalanobis distance test. The results of the multivariate results are reported in Table 11.

Table 11

Results of MANOVA show the effect of demographic groups on math achievement

| Effect | F | Hypothesis df | Error df | Sig. | Observed Power |
|-------------------|----------|------------------|----------|------|-------------------|
| Intercept | 21612.22 | 5 | 10716 | 0.00 | 1.00 |
| Location | 11.12 | 5 | 10716 | 0.00 | 1.00 |
| Gender | 10.54 | 5 | 10716 | 0.00 | 1.00 |
| Location * Gender | 1.20 | 5 | 10716 | 0.31 | 0.43 |

Method: Pillai's Trace , $\alpha = .05$

From the results of the MANOVA, it is evident that *school locations* had a significant effect across all of the categories of math achievement. All subsequent univariate tests of differences conducted with *school locations* were shown to be significant. The specific group mean differences between *school locations* were not reported due to an agreement with Saskatchewan Learning to not release any actual test results. However, there were significant differences such that students in the rural environment generally had a higher level of math achievement across all measures than the students in an urban school environment.

The test of gender differences from the results of the MANOVA was also significant within the AFL math achievement program. However, the *gender* differences from each individual category of learning were not as prominent as *school location* differences. While learning categories such as *fractions* and *measurement* were found to be significantly different in favour of male students, the remaining three categories (*geometry*, *whole numbers*, and *data analysis*) did not show significant differences between genders (see Table 12).

Table 12

ANOVA results of demographic categories on math achievement

| Source | Dependent Variable | df | df Error | F | Sig. | Observed Power(a) |
|-------------------|--------------------|----|----------|-------|------|-------------------|
| Location | Whole Numbers | 1 | 10,720 | 10.44 | 0.01 | 0.9 |
| | Fractions | 1 | 10,720 | 28.22 | 0.01 | 1 |
| | Geometry | 1 | 10,720 | 31.49 | 0.01 | 1 |
| | Measurement | 1 | 10,720 | 37.55 | 0.01 | 1 |
| | Data Analysis | 1 | 10,720 | 7.73 | 0.01 | 0.79 |
| Gender | Whole Numbers | 1 | 10,720 | 2.43 | 0.12 | 0.34 |
| | Fractions | 1 | 10,720 | 22.31 | 0.01 | 1 |
| | Geometry | 1 | 10,720 | 1.18 | 0.28 | 0.19 |
| | Measurement | 1 | 10,720 | 8.55 | 0.01 | 0.83 |
| | Data Analysis | 1 | 10,720 | 3.45 | 0.06 | 0.46 |
| Location * Gender | Whole Numbers | 1 | 10,720 | 0.71 | 0.4 | 0.13 |
| | Fractions | 1 | 10,720 | 1.11 | 0.29 | 0.18 |
| | Geometry | 1 | 10,720 | 0.78 | 0.38 | 0.14 |
| | Measurement | 1 | 10,720 | 0.05 | 0.83 | 0.06 |
| | Data Analysis | 1 | 10,720 | 4.74 | 0.03 | 0.59 |
| $\alpha = .05$ | | | | | | |

There were no interaction effects within the test results. All categories of learning were shown to have no significant differences, demonstrating that categorical differences exhibited by *school locations* and *gender* were not compoundable and should be treated as distinct factors that affect math achievement for grade five students in Saskatchewan.

In summary, the MANOVA demonstrated significant differences in math achievement based on *school locations* and *gender*. Specifically for grade five students in Saskatchewan, rural students performed better in the math assessment than urban students and girls performed better than boys. The lack of significance for an interaction of those two variables suggested girls from rural schools did not perform significantly better than girls from urban schools. Further discussions of these results are made in the next chapter.

This chapter presented the results of the data analysis in the order of the research questions posed. First, three of the four expected factors were successfully extracted from the responses. Next, the extracted factors were used in a multiple regression where it failed to model for math achievement. An alternate model was suggested, but was also unsuccessful in predicting math achievement. Last, significant differences in math achievement were found between student demographics using MANOVA. Implications and significance of the results are discussed in the next chapter.

Chapter 5

Discussion

The purpose of this chapter is to discuss the significant findings of the present study. The present chapter discusses: (a) findings of the study, (b) implications of the results, (c) limitations of the study; and (d) suggestions for future research. The goal of the study was to provide useful information to Saskatchewan Learning for policy implementation.

Findings

The purpose of the study was to explore the factors that affect math achievement for students in Saskatchewan. The study was conducted in phases using the results from a province-wide assessment program for grade five mathematics. First, an exploratory factor analysis was conducted on the responses for all the items on the questionnaire to identify possible learning factors. The exploratory factor analysis was unsuccessful because there were too many possible factors to interpret, and there were discrepancies in the interpretation of the factor results. A smaller subset of items from the questionnaire that had supportive evidence for achievement influences was also factor analyzed. The exploratory factor analysis extracted three possible factors: *confidence in math*, *parental involvement in math*, and *extracurricular involvement in math*. In the second phase of the study, a multiple regression was used to examine potential relationships between the possible factors extracted from the EFA and math achievement. The regression model used factor scores created from suggested factors to predict math achievement. The multiple regression analysis failed to suggest any significant prediction from the factor scores ($r^2 = .084$), which prompted a modification in the regression model using individual items. The use of individual items for regression modeling did not improve in predicting math achievement ($r^2 = .124$). Also, cross validation revealed a lack of robustness in the items because

some failed to remain significant in the model. Last, a Multivariate Analysis of Variance (MANOVA) was conducted to investigate whether there were any significant differences between groups based on *gender* and *school locations* with math assessment results as dependent variables. The results of the MANOVA suggested that math achievement scores were significantly different across *gender* and *school locations*, suggesting that differences exist for certain demographics. From the results discussed above, the following conclusions were made in the order of the hypotheses addressed.

Hypothesis 1a: There are factors that are identifiable in relation to math achievement.

The findings from the EFA were generally supportive of Hypothesis 1a, where factors were identifiable in relation to math achievement. Although the items used were not correlated to measures of math achievement, the EFA of all the questionnaire items identified showed trends in responses, which suggested for existence of such factors. The overwhelming support of the first six factors extracted in the EFA with all 100 items can be seen as encouraging; as the extracted factors could help identify and support the themes of learning skills for the upcoming personal/social skills assessment to be implemented for 2010 (Saskatchewan Learning's, 2007).

With only the exception of a few questions and previous validity evidence, the lack of validity evidence in the majority of the questions was evident in the results. As 23 out of 100 items were not able to load on the extracted factors, this suggested a lack of direction from the questions as completed by the students. Although all questions from the student questionnaires were designed to investigate for learning trends, the lack of clustering in student responses suggest the "barometric" way of determining student trends (as suggested by OTL) may not be effective in reflecting on the trends of students' learning environment (Saskatchewan Learning, 2000 b). Since the design of the questionnaire was based on seeking information according to the

OTL design, a large sample of responses should have yielded more learning trends amongst the students. It was disappointing to be unable to extract factors without discrepancies with a sample of 5,407.

Hypothesis 1b: The suggested factors are related to the themes that have emerged from previous reviews of math achievement models.

There was initial evidence to support this hypothesis from the PCA conducted, as three possible factors (*confidence in math, parental involvement in math, and extracurricular involvement in math*) did converge and were successfully extracted from the 17 item subset. However, upon further analysis, the three factors extracted were not very representative of the possible learning factors. This conclusion was derived from: (a) the low level of total variances accounted for by the extracted factors, and (b) the lack of internal consistency in one of the factors despite being successfully extracted. The lack of representativeness with the possible factors could be a result of an excessive amount of measuring error that affected representation of the learning trends, or a lack of external validity of the questions wording, as items had not been previously validated.

Another finding was that the factor *locus of control* was shown to be insignificant throughout both iterations of the EFA, suggesting that although previous research has suggested *locus of control* as a concept is significant in effecting math achievement, questions used in the present study could not successfully probe that concept. Lack of consensus may be attributed to having only two items available to demonstrate consensus in *locus of control*. The general convention of extracting a factor from an EFA requires that the questionnaire include at least two adequately loaded items in order for it to be considered a factor (Comrey & Lee, 1992). For

future consideration, the design of the questionnaire could be improved by establishing questions based on the three factors identified in the present study. In order to allow for questions to be organized in a consistent manner, the questions within the same factor should be related to each other in order to provide for statistical power in investigating certain generalized learning styles.

Hypothesis 2: The factors should have a significant relationship in effecting math achievement from the AFL results tested.

Although the regression model created has shown statistical significance, it accounted for a low proportion of variance ($r^2 = .124$). There are two possible explanations to cause this error in prediction. The first possible explanation was that there were important concepts left unaccounted for in the regression model for predicting math achievement. A few concepts that were suggested to be affective towards math achievement but were omitted in the regression were: SES (Dumais, 2006; Eccles et al., 1983), prior achievement (Eccles et al., 1983; Joshi, 1998), and levels of anxiety towards math (Adeyemo & Adetona, 2007; Joshi, 1998). This study did not explore these suggested factors because: (a) family SES was shown to be an indirect factor for parental involvement (Ethington, 1992), and such information was not available, (b) prior achievement information for the students was not available, and (c) the level of anxiety was reflected in the level of confidence in math.

A second reason for the low level of variance was the low internal consistency in the suggested factors. The lack of consistency in the responses from the questions within the same suggested category suggests that the factors identified were weak and contained large amounts of measurement error. Future studies could be improved by including concepts omitted in the

present study for a better representation and to validate questions used from a categorical standpoint that would allow for more conclusive results from the regression.

Hypothesis 3: No significant differences in mathematic achievement were found due to differences of school locations and gender.

The findings for this hypothesis, using MANOVA, were conclusive in showing significant differences between *school locations* and *gender* separately. Specifically, students attending a rural area school were outperforming students in an urban school environment, and male students achieved significantly higher scores than girls in grade five in Saskatchewan. This effect was not prevalent across all measures between genders, as significant gender differences were only found in three of the five categories of learning as tested by AFL.

The findings of this analysis were consistent with other studies on gender achievement differences specifically in math (Fan et al., 1997). However, there are different interpretations as to how the significant differences are attributed. Entwisle et al. (1994) attributed gender achievement differences to the availability of resources in the student s' surroundings. In comparison, Parsons et al. (1982) argued that gender achievement differences were partly caused by the feeling of helplessness being more prevalent in girls, where boys were less susceptible to feeling helpless at the same age. The current findings should encourage teachers in Saskatchewan to be more sensitive toward girls who may exhibit helplessness during math learning and to proactively offer help and support to students that may be in need of assistance.

The study originally predicted no significant differences between different locations of schools. This prediction was based on the utopian assumption that the quality of instruction was equal across all school locations. In contrast, the present study found that students from rural

schools outperformed students in urban schools. The study did not support the findings of Kannapel and DeYoung (1999), where student achievement in rural schools was found to be lower than their urban counterparts due to a lower budget and lack of proper teaching resources. The study also contradicted past findings that suggested teaching practices in rural schools were disorganized in Saskatchewan (Randhawa & Michayluk, 1975). Although the prevalent literature would contradict the conclusions of the present study, students in rural schools in Saskatchewan achieved higher math scores. Perhaps the higher scores were due to a higher level of attention paid to the students, a lower student teacher ratio, or the effort the Ministry has made to improve the status of rural schools.

The Ministry has recognized and studied pitfalls of rural schooling, and has implemented strategies to counter the pitfalls striving to ensure equal learning opportunities across the province. The following actions have been taken by the Ministry to meet this challenge: (a) schools have been reorganized into 28 districts, which have allowed resources to be pooled and managed collectively with more common goals in learning, (b) community school programs have been established to encourage engagement from the community to integrate into students' learning, and (c) additional funds and new implementations of distance education supports have allowed rural schools in Saskatchewan to thrive and compete with larger schools in urban areas (Saskatchewan Learning, 2007).

The current finding suggested that rural Saskatchewan students outperformed urban students. Fan and Chen (1999) supported this finding and attributed the rural success to a lower level of student enrollment in rural schools, which allowed teachers in rural schools to know and help their students at a more personal level and thus achieve better academic outcome. Since the implementations of other subjects such as science and writing skills are planned to be assessed in

a large-scale fashion in the near future, future studies should investigate achievement differences across all subjects assessed. Furthermore, the matter of location differences should be studied in a more detailed and specific manner. With sets of formative assessments conducted annually, the Ministry will have the opportunity to refine and expand the level of analysis that they conduct on the abundance of student results they receive. Further ideas of improvements are discussed in later sections.

Implications of Research

The current study attempted to apply available information collected by the Ministry in a novel method in order to gain further meanings from the dataset. Although the current findings were not conclusive in identifying the factors affecting math achievement from the questionnaire responses, the level of understanding gained in this study could be applied in two distinct perspectives: (a) to the consumers of the education in Saskatchewan (students and parents), and (b) the producers of the education process (educational administrators).

Implications for Students and Parents

Student questionnaires have often been administered with large-scale assessments, but the results of such questionnaires have not been used for the analysis of the assessment results in Saskatchewan. AFL's student opinion questionnaire has been reported in a descriptive manner and the results have been reported independently from the assessment results. The implication in the current study, to predict one set of results from another, was to raise awareness among parents of Saskatchewan on the importance of learning influences they present to their children. The items for *confidence in math* have indicated a positive correlation with math achievement; therefore parents should encourage and allow for their children to develop a strong sense of confidence in their abilities to do math. This implication can be corrected by providing

secondary resources such as a sufficient level of encouragement and motivation in student math learning (Reyes, 1984). Although level of confidence may not ensure better math achievement (Jones & Smart, 1995), the development of confidence has been overshadowed by negative findings of math anxiety. Therefore, raising awareness for the importance of confidence in math achievement is imperative.

The positive correlations between parental involvement with math achievement and extracurricular activities have been suggested as beneficial for children's development (Ma & Klinger, 2000; Papanastoasiou & Bottiger, 2004). Studies have shown students participating in the math club were perceived to be more motivated and confident in math (Papanastoasiou & Bottiger, 2004), suggesting that participation in extracurricular activities in math would be beneficial for math achievement. Alternatively, parents must be aware of how they are involved with their children's school work, as certain types of parental involvement (such as performance goal statements and negatively affective statements) are negatively correlated with student achievement (Hokoda & Fincham, 1995). Parents also need to be aware of their children's levels of learned helplessness, as their children may underachieve when given too much attention from their parents (Wagner & Phillips, 1992).

It should be noted here the implications presented above were derived from the correlation values of the study because there were not enough support from the results of the regression model. This confound in evidence have limited the implication of this study as the conclusions were drawn with the support of the past literature and correlation values. The limitation of the student questionnaire is the issue with the lack of support from the regression model, which will be discussed in a later section.

Implications for Education Administrators

The study has demonstrated the benefits of conducting analyses to aid in the informed decision-making process with the Ministry. Based on the analysis of student opinion

questionnaires and assessment results, suggestions can be made to improve the assessment program. The suggestions discussed below can be summarized into three themes: (a) the need to modify the questionnaire based on the original themes of OTL to better reflect changes in student trends; (b) the need to modify education curricula based on student learning trends, and (c) the need to reevaluate and refine needs based on demographic results. The Ministry could implement the above suggestions to improve student representation for the upcoming AFL personal/social skills assessments to be deployed in 2010.

Although the administration of the student questionnaire provides useful information from students, it lacks evidence of validity and reliability in its design. While the Ministry intends to retain the questionnaire in an informative design with less emphasis on the research aspect (Saskatchewan Learning, 2000 b), it is time for the questionnaire to incorporate for preplanned factors to investigate student learning trends such as the factors discussed in this study or factors that were determined in the OTL. The reasons are: (a) to accommodate the increase in demand for higher accountability in education, (b) to maintain the questionnaire's role as a measurement of current student learning trends and learning opportunities, and (c) to allow for a more accurate depiction of funding in need for special learning environments. In addition, if questions were to include evidence concerning validity in a manner similar to the math assessment questions, the questionnaire could be more informative as it could probe more factors. Lastly, the scale of the responses needs to be consistent throughout the survey in order to allow questions to be analyzed in a more interpretive manner than providing only simple frequency statistics.

Based on the findings from the EFA and the regressions, it is evident that learning styles affect student achievement in math. In conjunction with the current curriculum redesign in

mathematics, in order to engage parents with student learning, the Ministry should ensure that cooperative learning opportunities are available as students' confidence towards math could be nurtured. In addition, extracurricular activities related in math such as mathlete, math clubs, or chess clubs should be encouraged to provide students with more opportunities to allow them to refine their math skills outside of the classroom. The importance of the findings for the study is that the level of student math achievement is related to their interactions with others using their skills; therefore the Ministry should encourage students to apply their classroom knowledge outside of the classroom environment. For example, having small building projects that require measurement or applying relevant math knowledge during field trips. Studies have confirmed the importance of interactive learning activities, as it encourages student engagement for learning as well as improving student academic achievement (Balli, Demo & Wedman, 1998).

Findings from the MANOVA suggest that *school locations* and *gender* differences persist for students in Saskatchewan. Specifically, rural schools tend to succeed in providing quality of math education to prepare their students according to the math curricula. While this achievement difference may be a general trend with no considerations to the issues with the complexity of urban learning environments or higher student populations in urban areas. The focus of the Ministry should concentrate on raising the overall level of math achievement in the province. In addition, the Ministry should also consider gender differences because gender differences are evident in grade five students, especially in concepts such as *fractions*, *measurement*, and *data analysis*.

In recent years, the AFL program in Saskatchewan has grown to accommodate a larger demand for accountability in education. In order to accommodate a larger student dataset, and to derive more findings from the results, the Ministry should consider using more complex data

analyses, as the results would be beneficial for many parties concerned. In addition to providing more information that may be beneficial for the purposes of curriculum development or funding decisions, the results of studies may concern such organizations as parent teacher committees to increase parental involvement, or it could be used as support for teachers and policy makers to design new programs to improve student achievement.

Limitations

There were issues that may limit the findings of the study; the following section is to address the issues, and to explore how they could be handled in future studies. The issues were: (a) the high level of measurement error and the lack of validity in the student questionnaire; (b) students' levels of comprehension of the student questionnaire, and (c) the lack of validity in the AFL assessment questions as a measure of math achievement.

The high level of measurement error associated with the responses from the student questionnaire was the primary limitation of the present study. As the questionnaire was originally designed to probe student learning styles and behaviors based on the Opportunity to Learn model (OTL; Saskatchewan Learning, 2000 b), questions in the survey were not tested or validated to demonstrate for validity in prompting the response for which it probed (i.e., whether questions regarding student readiness are about the concept of student readiness). As a result, the level of measurement error persists because items in the questionnaire were not validated prior to use. The high level of error in measurement led to a low amount of variance accounted-for in the regression model. The cause for such high measurement error may be due to one of the following reasons: (a) measures were not measuring what they were designed to measure, (b) the measures used were not significantly different for use in the current study or (c) other unidentified or underlying factors were not accounted for in predicting math achievement. The use of cross

validation techniques in the regression models confirmed for the existence of measurement error in the responses (i.e., the first model of regression was created with 80% of the sample, while the second regression model used 20% of the population to confirm the existence of measurement error for the variables used in the first model). Alternatively, the problem with the low variance may be due to the wording of scales used in the questionnaire (to be discussed in a later section) or the different scales used in the questionnaire (such as the difference in scaling from the use of a Likert-type response or binary options where students check off opinions that apply to them). The different representation of scales in different questions may have prompted a lack of representation of the concept the question represented. Future studies should use consistent response types to the same response set, or should investigate other statistical methods that would better accommodate for different types of response, as past studies have shown EFA to be ineffective when different types of data are used at once such as using two point and four point scales in the same EFA (Muthen & Kaplan, 1985).

Respondent comprehension may have been a limitation of the study. As the student opinion questionnaires were administered to students participating in the math assessment program, the wording of the questions and the complexity of the response options may have been too difficult for the students in lower grades, such as grade five students. An example of the complexity of the wording demonstrated in questions 15 and 21, where the questions asked:

Question 15: Manipulatives are objects or materials that are used in mathematics to help you understand ideas and solve problems (Ex: pattern blocks, base ten blocks, dice, geoboards, algebra tiles, graphing calculators, etc.). On average, how many times a week do you use manipulatives? (Saskatchewan Learning 2, 2007)

Question 21: Are you happy with how well your family supports your learning? (Saskatchewan Learning 2, 2007)

While the wording of the questions may not be difficult, the ideas posed may be too complex for a grade five student to understand, as questions shown above involved understanding with abstract ideas and theoretical circumstances. This issue of comprehension is a common issue with questionnaire design, as the questions should cater towards the audience of the question, explained in the most direct and simple manner (Taylor-Powell, 1998). In question 15, the wording of the question is overcomplicated for as the concept of the question had to be defined prior to the question, while question 21 may be double barreled, as the question asks how the family is supporting the student's learning, and also are they happy with the level of support that he or she is provided. The designers of the questionnaire have to consider the respondents are in elementary education, hence should be even more sensitive towards the pitfalls of questionnaire design.

The issue of comprehension may be beyond the semantics of the questions. While the students may understand the wording of the questions semantically, and the teachers would be there to answer and clarify questions student may not understand. The student may answer the questions without comprehending the questions conceptually. Examples of this issue is demonstrated in questions seven and 17-20, where question seven asked how students' feel about the comment "I feel confident when I do mathematics question", and question 17-20 prompted a reply if the student agreed with the comment "I feel confident in learning math" . While both questions asks for the same concept and may differ only in wording, the coefficient alpha between the two responses was only .24. The low coefficient alpha proved to be problematic as questions seem to be probing similar ideals, but the existence of response differences demonstrated that responses may be based on a confounding concept.

The last limitation is the use of formative assessment results as a measure of math achievement to explain learning trends in the current study. While formative results are informative in addressing issues with learning math, they may not be an accurate measure of how much a student has learned. The measure of math achievement in this study, specifically with the regression modeling and the MANOVA, was reliant on the use of the 40 multiple-choice responses administered in the AFL math assessment. Since there had been diverse concepts that contributed to math achievement, the five categories of math achievement as designated by AFL (see Table 2) could not have incorporated all aspects of math achievement in the 40 questions used. This is evident with the large variance with the scores as shown in the standard deviation of the scores in Table 6. The large variance in the scores could suggest the measures of math achievement in this model are insufficient for representation. However, further studies should explore other reliable math assessment programs for a better representation of math achievement.

In addition, formative assessment results have traditionally been used to inform the level of math achievement the students are capable of attaining. The current study used results of AFL's formative assessment as a dependent variable to explain issues that affect math achievement. This decision shifted the role of assessment results from explaining for math achievement, to a measure of math achievement. The attempt to use formative assessment results as a measure of math achievement has rarely been implemented, therefore there is a lack of precedence for evidence of validity and reliability in using those AFL assessment responses to represent the true concept of math achievement. Ungerleider (2006) raised similar concerns as the results of math achievement may not accurately depict an actual improvement of student learning. There have been studies that used large scale assessments to relate learning style differences with assessment results (Anderson et al. 2006, Ho & Willms, 1996), but there has

been a lack of a study investigating for differences of learning styles of students in Saskatchewan. Although the concept of math achievement can never be measured objectively, further studies should be conducted to investigate external and convergent validity in the AFL results by referencing with other large scale evaluative measures.

The limitations of this study were mostly pertaining to difficulties in using results provided by AFL. This limitation is not uncommon in analyzing data from large scale assessments, as other studies using large scale assessment data have also resulted in low variances accounted for (Adayemo & Adetona, 2007; Anderson et al., 2006). While such concerns are generally prevalent in secondary data analyses, future studies seeking to explore large-scale assessment results could take strategies acquired from the current study. The following section discusses future directions in investigating reasons for math achievement in Saskatchewan, focusing on the application of assessment data such as geographical representation and complex modeling.

Future Directions

The curriculum designs for Saskatchewan Learning (Ministry) are currently undergoing a paradigm shift in order to better prepare students in Saskatchewan for success (Saskatchewan Learning, 2006). Specifically, the shift in design is to accommodate an increase in public sensitivity towards accountability in education. The Ministry responded to the demand by striving to establish highly responsive and accountable learning systems as their goal (Saskatchewan Learning, 2007). In addition, the establishment of the Assessment for Learning (AFL) program is part of the Ministry's solution to increase accountability in education. AFL will continue to expand from the current reading and mathematics assessments to include such disciplines as sciences, writing, and personal/social skills by 2010. The purpose of developing

large-scale assessments is to provide more student information to conduct informed planning and monitoring in school divisions (Saskatchewan Learning, 2007). The assessment format will remain in a formative nature, with a focus on students' level of learning. The assessment format is unlike the summative approach used in other provinces focusing on students' individual achievements.

The future development of the AFL program will include consultations with teaching and curriculum design professionals across the province, where future development will be based on the Continuous Improvement Framework (CIF; Saskatchewan Learning, 2006). The advantage of incorporating the CIF framework in the AFL program is to strengthen teaching, and to ensure that resources be distributed to areas in need (Saskatchewan Learning, 2006). With a large demand in changing and designing assessment programs, the findings of the present study could be applied to produce useful information for educators and policy makers in Saskatchewan.

The statistically significant differences amongst different school locations have confirmed that a relationship exists between school locations and student math achievement. Due to a restriction on personal information released by the Ministry, specific school locations were only identified by whether they were within an urban environment or a rural environment. To better distinguish learning differences from school locations, a geographical analysis could be used to analyze assessment data. With the cooperation from the Ministry, future studies could utilize Geographical Information Systems (GIS) to geographically profile large scale assessment results in order to investigate areas for improvement by releasing postal codes of students' schools or residences. While GIS has been integrated in studies in the field of criminology and sociology, it is rarely applied in the field of education. The integration of geographical analysis with assessment results could provide information to improve students' academic achievements,

which could efficiently provide extra resources for neighborhoods, schools or districts depending on perceived needs. The implication of incorporating geomatics suggested here is not to segregate and criticize the achievement differences between different areas of the province, but to place more focus on the response differences on the student questionnaire, so that educators have a better idea of how their student is learning or values learning in certain areas.

From the results of the regression model, the low level of variance accounted-for in the model could be improved by taking the teachers' or schools' teaching practices into account. The current study did not employ any responses from teachers. Since the AFL program administered teaching practice surveys to teachers as well as principals, future studies could explore the use of hierarchical modeling to include such results to examine whether teachers' or administrators' teaching beliefs are related to student achievements. The attribution of teachers' and schools' opinions on the outcomes of math achievement has been studied in the Canadian context but not specifically in Saskatchewan (CMEC, 2003).

In summary, from the findings of the present study, the future direction should allow for more exploration of large-scale assessment results, as the datasets are readily available but few have been explored. The use of data obtained from the Ministry for secondary analysis is beneficial for both the Ministry and the researchers involved in the study. The data saved time and resources during the process of the study for both parties concerned. Collaboration of efforts can expedite the research process, and provide useful information that benefits the Ministry.

References

- Adeyemo, D. & Adetona, M. (2007). A path analytic study of the personality factors affecting students' learning outcomes in mathematics. *European Journal of Scientific Research*, 18(1), 118-133.
- Adrian, M. (1978) The relationship of self-concept of science and mathematics achievement and the operative comprehension of reading content. *Dissertation Abstracts International*, 39, 764.
- Alspaugh, J. & Harting, R. (1995) Transition effects of school grade-level organization on student achievement. *Journal of Research and Development in Education*, 28, 145-149.
- Alspaugh, J. (1992). Socioeconomic measures and achievement: Urban vs. rural. *Rural Educator*, 13, 2-7.
- Anderson, J., Rogers, T., Klinger, D., Ungerleider, C., Glickman, V., & Anderson, B. (2006). Student and school correlates of mathematics achievement: Models of school performance based on pan-Canadian student assessment. *Canadian Journal of Education*, 29(3), 706-730.
- Balli, S., Demo, D. & Wedman, J. (1998). Family involvement with children's homework: An intervention in the middle grades. *Family Relations*, 47(2), 149-157.
- Bandura, W. (1971). *Social Learning Theory*. Morristown, NJ: Gen Learning Press.
- Bandura, A. (1989). Social cognitive theory. In R. Vasta (Ed.), *Annals of child development*. Vol. 6. *Six theories of child development* (pp. 1-60). Greenwich, CT: JAI Press.
- Barta, J. & Shockey, T (2006). The mathematical ways of an aboriginal people: The northern ute. *The Journal of Mathematics and Culture*, 1(1), 79-89.

- Beck, F. & Shoffstall, G. (2005) How do rural schools fare under a high stakes testing regime? *Journal of Research in Rural Education*, 20(14). Retrieved 11 November, 2007 from <http://jrre.psu.edu/articles/20-14.pdf>
- Biggs, J. (1985). The role of meta-learning in study processes. *British Journal of Educational Psychology*, 55, 185-212.
- Carroll, J. (1982). A model of school learning. In L. Anderson (Ed.), *Perspectives of School Learning* (p. 19-49).
- Cates, G. & Rhymer, K. (2003). Examining the relationship between mathematics anxiety and mathematics performance: An instructional hierarchy perspective. *Journal of Behavioral Education*, 12(1), 23-34.
- Chambers, E. A., & Schreiber, J. B. (2004). Girl's academic achievement: Varying
- Chen, P. (2002). Exploring the accuracy and predictability of the self-efficacy beliefs of seventh-grade mathematics students. *Learning and Individual Differences*, 14(1), 77-90.
- Coleman, J., Hoffer, T. & Kilgore, S. (1982). *High school achievement*. New York, NY: Basic Books.
- Comrey, A. & Lee, H. (1992). *A First Course in Factor Analysis*. Hillsdale, NJ: Lawrence Erlbaum.
- Council of Ministers of Education, Canada. (2003). School achievement indicators program (SAIP), Mathematics III Assessment. Toronto: Author.
- Cronbach, L. & Meehl, P. (1955). Construct validity in psychological tests. *Psychological*

Bulletin, 52, 281-302.

Crosswhite, F. (1972) *Correlates of attitudes toward Mathematics* (National Longitudinal Study of Mathematical Abilities, Report 20). Palo Alto, CA : Stanford University Press.

du Plessis, V., Beshiri, R., Bollman, R. & Clemenson, H. (2002). Definitions of rural.

Agriculture and Rural Working Paper.61. (Catalogue no. 21-601-MIE).

DiIorio, C. (2005). *Measurement in health behavior: methods for research and evaluation*. San Francisco, CA: Jossey-Bass.

Driessen, G., Smit, F. & Sleegers, P. (2005). Parental involvement and educational achievement. *British Educational Research Journal*, 31(4), 509-532.

Dumais, S. (2006). Elementary school students' extracurricular activities: The effects of participation on achievement and teachers' evaluations. *Sociological Spectrum*, 26(2), 117-147.

Dunn, R., Dunn, K. & Price, G. (1989). An Inventory for the identification of individuals in Grades 3 through 12 prefer to learn, *Learning Style Inventory*.

Eccles, J., Adler, T. F., Futterman, R., Golf, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. Spence (Ed.), *Achievement and Achievement Motivation* (pp. 75-146). San Francisco: W. H. Freeman.

Eccles, J., Kaczala, C. & Meece, J. (1982) Socialization of achievement attitudes and beliefs: classroom influences, *Child Development*, 53(2), 322-339.

- Edington, E. & Koehler, L (1987). Rural student achievement: elements for consideration. Las Cruces, NM: New Mexico State University. (ERIC Document Reproduction Service No. ED 289685)
- Entwisle, D., Alexander, K. & Olson, L. (1994). The gender gap in math: Its possible origins in neighborhood effects. *American Sociological Review*, 59(6), 822-838.
- Epstein, J. (2001). *School, family, and community partnerships: preparing educators and improving schools*. Boulder, CO: Westview.
- Ethington, C. (1992). Gender differences in a psychological model of mathematics achievement. *Journal for Research in Mathematics Education*, 23(2), 166-181.
- Fan, X. & Chen, M. (1999). Academic achievement of rural school students: A multi-year comparison with their peers in suburban and urban Schools. *Journal of Research in Rural Education*. 15(1), 31-46.
- Fan, X., Chen M. & Matsumoto, A. (1997). Gender differences in mathematics achievement: Findings from the national education longitudinal study of 1988. *The Journal of Experimental Education*, 65(3), 229-243.
- Fennema, E., & Peterson, P. (1985). Autonomous learning behavior: A possible explanation of gender-related differences in mathematics. In L. Wilkinson & C. Marrett (Eds.), *Gender influences in classroom interaction* (p. 17-35). New York: Academic Press.
- Gall, J., Gall, M., & Borg, W. (1999). *Applying educational research: A practical guide (4th ed.)*. New York: Addison Wesley Longman.

- Greenberg, E. & Teixeira, R. (1995). Nonmetro student achievement on par with metro. *Rural Development Perspectives*, 10, 17-23.
- Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics Education*, 34(1), 37-73.
- Haller, E., Monk, D. & Tien, L. (1993). Small schools and higher-order thinking skills. *Journal of Research in Rural Education*, 9, 66-73.
- Ho, E. & Willms, J. (1996). Effects of parental involvement on eighth-grade achievement. *Sociology of Education*, 69, 126-141.
- Ho, E. & Willms, J. (1996). Effects of parental involvement on eighth-grade achievement. *Sociology of Education*, 69, 126-141.
- Hokoda, A. & Fincham, F. (1995) Origins of children's helpless and mastery achievement patterns in the family. *Journal of Educational Psychology*, 87(3), 375-385.
- Jeynes, W. (2005). A meta-analysis of the relation of parental involvement to urban elementary school student academic achievement. *Urban Education*, 40(3), 237-269.
- Jones, L., & Smart, T. (1995). Confidence and mathematics: A gender issue? *Gender and Education*, 7, 157-166.
- Joshi, H. (1998). *Determinants of Mathematics Achievement using Structural Equation Modeling*. Retrieved from Canadian Theses (AMICUS 18222788).
- Kannapel, P. J., & DeYoung, A. J. (1999). The rural school problem in 1999: A review and critique of the literature. *Journal of Research in Rural Education*, 15(2), 67-79.

- Keith, T., Reimers, T., Fehrman, P., Pottebaum, S. & Aubrey, P. (1986). Parental involvement in homework and TV time: direct and indirect effects on high school achievement. *Journal of Educational Psychology*, 78, 373-380.
- Kopsovich, R., (2001). *A Study Of Correlations Between Learning Styles Of Students And Their Mathematics Scores On The Texas Assessment of Academic Skills Test*. Unpublished doctoral dissertation. University of Northern Texas, Denton, TX.
- Kulm, G. (1980). Research on mathematics attitude. In R. Shumway(Ed.), *Research in mathematics education*. Reston, VA: National Council of Teachers in Mathematics.
- Laszlo, J. & Sainsbury, K. (1993). Perceptual-motor development and prevention of clumsiness. *Psychological Research*, 55(2), 167-174.
- Lawrence, D. (1985). Improving self-esteem and reading. *Educational Research*, 27(3), 194-200.
- Li, J. (2001). Expectations of chinese immigrant parents for their children's education: the Interplay of chinese tradition and the canadian context. *Canadian Journal of Education*, 26(4), 477-494.
- Ma, X. & Kishor, N. (1997). Assessing the relationship between attitude toward mathematics and achievement in mathematics: A meta-analysis. *Journal for Research in Mathematics Education*. 28, 26-47.
- Ma, X & Klinger, D (2000). Hierarchical linear modeling of student and school effects on academic achievement. *Canadian Journal of Education*, 25(1), 41-55.

- Ma, X. (1999). A Meta-Analysis of the Relationship between Anxiety toward Mathematics and Achievement in Mathematics. *Journal for Research in Mathematics Educaion*. 30(5), 520-540.
- Marsh, H. & Yeung, A. (1998). Longitudinal structural equation models of academic self-concept and achievement: Gender differences in the development of math and english constructs. *American Educational Research Journal*, 35(4), 705-738.
- McLanahan, S (1985). Family structure and the reproduction of poverty. *American Journal of Sociology*, 90, 873-901.
- Meece, J. (1982) Sex differences in math achievement: Toward a model of academic choice. *Psychological Bulletin*, 91(2), 324-348.
- Mittelberg, D. & Lev-Air, L. (1999). Confidence in mathematics and its consequences: Gender differences among israeli jewish and arab youth, *Gender and Education*. 11(1), 75-92.
- Morgan, S. & Sorenson, A. (1999). Parental networks, social closure, and mathematics learning: A test of coleman's social capital explanation of school effects. *American Sociological Review*, 64(5), 661-681.
- Muthén, B., & Kaplan D. (1985). A comparison of some methodologies for the factor analysis of non-normal likert variables. *British Journal of Mathematical and Statistical Psychology*, 38, 171-189.
- Myers, D. E., & Milne, A. M. (1988). Effects of home language and primary language on mathematics achievement. In R. R. Cocking & J. P. Mestre (Eds.), *Linguistic and cultural*

- influences on learning mathematics* (pp. 259–293). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Newman, R. & Goldin, L. (1990). Children's reluctance to seek help with schoolwork. *Journal of Educational Psychology*, 82(1), 92-100.
- Nicholls, J. (1978). The development of the concepts of effort and ability, perception of academic attainment and the understanding that difficult tasks require more ability. *Child Development*, 49(3), 800-814.
- Nunnally J. (1978) *Psychometric Theory*. New York, NY: McGraw-Hill.
- Papanastasiou, E. & Bottiger, L. (2004) Math clubs and their potentials: Making mathematics fun and exciting. A case study of a math club. *International Journal of Mathematics Education in Science and Technology*. 35(2), 159-171.
- Parsons, J., Meece, J., Adler, T. & Kaczala, C. (1982) Sex Differences in attributions and learned helplessness. *Sex Roles*, 8(4), 421-432.
- Pong, S. (1997). Family structure, school context, and eighth-grade math and reading achievement. *Journal of Marriage and the Family*, 59(3), 734-746.
- Taylor-Powell, E. (1998) Questionnaire Design: Asking questions with a purpose. University of Wisconsin Extension.
- Program for International Student Achievement (2007). *PISA 2006: Science Competencies for Tomorrow's World, Executive Summary*. Retrieved January 30, 2008, from <http://www.pisa.oecd.org/dataoecd/15/13/39725224.pdf>.

- Program for International Student Achievement, 2000 (2003). Retrieved October 30, 2007, from <http://www.pisa.oecd.org/dataoecd/58/57/33918098.pdf>
- Randhawa, B. & Michayluk, J. (1975). Learning environment in rural and urban classrooms. *American Educational Research Journal*, 12(3), 265-279.
- Randhawa, B., Beamer, J., & Lundberg, I. (1993). Role of mathematics self-efficacy in the structural model of mathematics achievement. *Journal of Educational Psychology*, 85(1), 41 – 48.
- Reyes, L. (1984). Affective variables and mathematics education. *The Elementary School Journal*, 84(5), 558-581.
- Rose, H. and Betts, J.R. (2001). *Math matters: The links between high school curriculum, college graduation, and earnings*. San Francisco, CA: Public Policy Institute of California.
- Saskatchewan Learning (2000a). *Saskatchewan Education Paper: Opportunity to Learn in Saskatchewan – Describing its Measurement and reporting at the Provincial Level*. Regina: SK.
- Saskatchewan Learning (2000b). *Saskatchewan Education Paper: Definitions and Models of Opportunity to Learn*. Regina:SK.
- Saskatchewan Learning (2000c). *Saskatchewan Education Paper: Contexts and Implications for Measuring and Reporting Opportunity to Learn*. Regina: SK.
- Saskatchewan Learning (2004). *Assessment for Learning: Supporting Data-Guided Decision Making to Improve Student Learning*. Regina: SK.
- Saskatchewan Learning (2006). *Saskatchewan Learning: Pre-K-12 Continuous Improvement Framework Guide*. Regina: SK.

Saskatchewan Learning (2007). *Annual Report for 2006-2007*. Regina: SK.

Saskatchewan Learning (2007a). *Assessment for Learning Program 2007: Math Grade 5 Scoring Guide*. Regina: SK.

Saskatchewan Learning (2008). *Assessment for Learning Program 2007: Math, Conference Call Agenda*. Retrieved on 12 February, 2008, from
http://www.learning.gov.sk.ca/adx/adxGetMedia.aspx?DocID=799,553,1796,615,200,135,107,81,1,Documents&MediaID=1019&Filename=mar12_conf_call.pdf

Sheldon, S. & Epstein, J. (2005). Involvement counts: Family and community partnerships and mathematics achievement. *The Journal of Educational Research*, 98(4), 196-206.

SPSS Inc. (2006) SPSS 14 for Windows, SPSS Inc, Chicago.

Statistics Canada (2005). *Learning a Living: First Results of the Adult Literacy and Life Skills Survey*. Statistics Canada Catalogue number 89-603-XWE. Ottawa and Paris: Statistics Canada and the Organisation for Economic Co-operation and Development.

Stipek, D. & Weisz, J.(1981). Perceived personal control and academic achievement. *Review of Educational Research*, 51(1), 101-137.

Stipek, D., Givvin, K., Salmon, J. & MacGyvers, V. (2001). Teachers' beliefs and practices related to mathematics instruction. *Teaching and Teacher Education*. 17(1), 213-226.

Tabachnick, B. & Fidell, L. (2006). *Using multivariate statistics*. Needham Heights, MA: Allyn & Bacon.

Texas Education Agency (1997), TAAS Bulletin.

- Tsang, S. (1988). The mathematics achievement characteristics of Asian- American students. In R. R. Cocking & J. P. Mestre (Eds.), *Linguistic and cultural influences on learning mathematics* (p. 123–136). Hillsdale, NJ: Lawrence Erlbaum.
- Ungerleider, C., (2006) Reflections on the use of large-scale student assessment for improving student success. *Canadian Journal of Education*. 29(3), 873-883.
- Vinner, S. (1997). The pseudo-conceptual and the pseudo-analytical thought processes in mathematics learning. *Educational Studies in Mathematics*, 34(2), 97-129.
- Wagner, B. & Phillips, D. (1992). Beyond beliefs: Parent and child behaviors and children's perceived academic competence. *Child Development*, 63(6), 1380-1391.
- Walberg, H. (1981). A Psychological theory of educational productivity. In F. Farley & N. Gordon (Eds.), *Psychology and Education*. Chicago, IL: National Society for the Study of Education.
- Weiner, B. (Ed.), (1974). *Achievement motivation and attribution theory*. Morristown, NJ: General Learning Press.
- Wilson, S. (1985). Differences in elementary math instruction and achievement among districts of varying size in the state of Washington. *Research in Rural Education*, 3, 51-55.
- Young, D. (1998). Rural and urban differences in student achievement in science and mathematics: A multilevel analysis. *School Effectiveness and School Improvement*, 9(4), 386-418.

Zill, N (1994). Understanding why children in stepfamilies have more learning and behavior problems than children in nuclear families. In Booth & Dunn (Eds.). *Stepfamilies: Who benefits? Who does not?* Hillsdale, NJ: Erlbaum.

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Appendix I

AFL Student Questionnaire



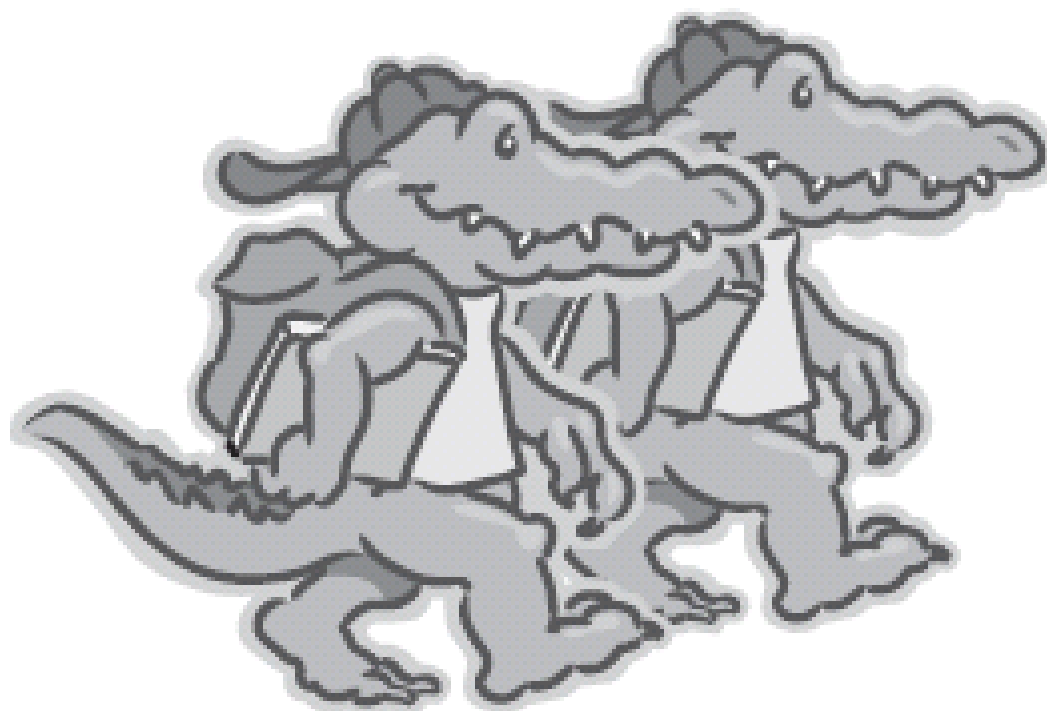
Assessment for
Learning



SQM05

STUDENT QUESTIONNAIRE

Grade 5



**Assessment for Learning Program
Mathematics - 2007**

Directions to the Student



- ☞ Your answers on this questionnaire are **important**. Please think carefully about the questions before you answer them.
- ☞ Your answers are **anonymous**. This means that no one will know you gave these answers.
- ☞ **Answer all questions**. Ask your teacher to explain questions you do not understand.
- ☞ This questionnaire is mostly made up of multiple-choice questions.
- ☞ Answer each question by filling in the circle ○ for the answer you choose.
- ☞ Please do not put any marks on the circles **not** selected.
- ☞ Please use **pencil** and fully erase any changes.

- Please fill in the
● selected circle
○ completely for
○ each question.



Fill in only one circle for each of the following questions.

| | |
|--|---|
| 1. a) What is your gender? <input type="radio"/> male <input type="radio"/> female | 1. b) Is <u>English</u> your first language? <input type="radio"/> yes <input type="radio"/> no → Please specify: _____ <i>(Ex: French, Cree, Ukrainian, Dene)</i> |
| 1. c) Are you of Aboriginal descent? <i>(This is a voluntary declaration.)</i> <input type="radio"/> yes → Please specify: _____ <input type="radio"/> no <i>(Ex: Cree, Dene, Inuit, Métis, Saulteaux)</i> | |

2.

How many hours per week
do you usually spend ...

| | none | less than 2 hrs./week | 2 - 7 hrs./week (less than 1 hr./day) | 7 - 14 hrs./week (1-2 hrs./day) | more than 14 hrs./week (more than 2 hrs./day) |
|---|-----------------------|-----------------------|--|------------------------------------|--|
| watching TV and/or movies? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| "surfing" the Internet? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| playing sports? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| participating in music, dance, art, etc.? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| using technology to talk to others (e-mail, chat rooms, telephone, text messaging, etc.)? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| going to club activities (cadets, girl guides, youth groups, etc.)? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| working for pay (babysitting, paper route, job, etc.)? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| volunteering in school, community, church or other activities? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| playing video games? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| doing chores or helping out at home? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

3. What is the highest level of schooling or education you want to complete?

- ☐ less than Grade 12
- ☐ Grade 12
- ☐ 1-year certificate program (Ex: cook, photographer)
- ☐ 2-year diploma program (Ex: carpenter, technician)
- ☐ 4-year university degree program (Ex: teacher, social worker, engineer)
- ☐ more than 4-year program (Ex: veterinarian, doctor)



4. What level of schooling or education do your parents or guardians want you to complete?
- ☐ less than Grade 12
 - ☐ Grade 12
 - ☐ 1-year certificate program (Ex: cook, photographer)
 - ☐ 2-year diploma program (Ex: carpenter, technician)
 - ☐ 4-year university degree program (Ex: teacher, social worker, engineer)
 - ☐ more than 4-year program (Ex: veterinarian, doctor)
5. Our school has high expectations for its students and encourages us to do well in our education.
- ☐ strongly agree
 - ☐ agree
 - ☐ disagree
 - ☐ strongly disagree
6. What do you think of the statement: "I like mathematics"?
- ☐ strongly agree
 - ☐ agree
 - ☐ disagree
 - ☐ strongly disagree
7. What do you think of the statement: "I feel confident when I do mathematics questions"?
- ☐ strongly agree
 - ☐ agree
 - ☐ disagree
 - ☐ strongly disagree
8. Do you learn mathematics most easily when you
- ☐ listen to the teacher?
 - ☐ read the examples in the textbook?
 - ☐ work on a computer?
 - ☐ work on problems with other students?
 - ☐ work on problems by yourself?
9. To do well in mathematics at school, which is most important?
- ☐ I need to be interested in mathematics.
 - ☐ I need good luck.
 - ☐ I need to do lots of work at school.
 - ☐ I need to do lots of work at home.
 - ☐ I need to have good natural ability.



10. On average, how much time each week do you spend doing math homework, math activities, or studying math outside of class time?

- ☐ never
- ☐ some time, but less than 1 hour
- ☐ 1 - 2 hours
- ☐ 2 - 3 hours
- ☐ 3 - 4 hours
- ☐ more than 4 hours



11. On average, how much time each week do you spend using a computer in your math class to learn or practice mathematics?

- ☐ never
- ☐ 0 - 15 minutes
- ☐ 15 - 30 minutes
- ☐ 30 - 60 minutes
- ☐ 1 - 2 hours
- ☐ more than 2 hours



12. Where do you use a calculator for mathematics?

- ☐ I use a calculator for mathematics **only at school**.
- ☐ I use a calculator for mathematics **only at home**.
- ☐ I use a calculator for mathematics **both at school and at home**.
- ☐ I don't use a calculator for mathematics.

13. Do you use the Internet for math-related activities?

- ☐ Yes, **only at school**.
- ☐ Yes, **only at home**.
- ☐ Yes, **both at school and at home**.
- ☐ No, I don't use the Internet for mathematics.

14. On average, how many times a week in math class do you work in pairs or small groups?

- ☐ never
- ☐ once
- ☐ twice
- ☐ three times
- ☐ four or more times

15. Manipulatives are objects or materials that are used in mathematics to help you understand ideas and solve problems (Ex: pattern blocks, base ten blocks, dice, geoboards, algebra tiles, graphing calculators, etc.). On average, how many times a week do you use manipulatives?

- ☐ never
- ☐ once
- ☐ twice
- ☐ three times
- ☐ four or more times

16. In what ways is the mathematics you learn in your classroom useful? Mark all that apply.

- ☐ It is useful for everyday life.
- ☐ It helps me when I do work in other subjects.
- ☐ I think it will help me in my future schooling.
- ☐ I think it will help me get a good job.
- ☐ I don't think it is useful.

You can fill in more than one circle for this question.

17.

| Fill in the circle for all the statements that apply to you! | |
|--|--|
| <input type="radio"/> Math is easy to understand. | <input type="radio"/> I like to solve hard math problems. |
| <input type="radio"/> I like working on math projects. | <input type="radio"/> I like to <u>explain</u> how to do math questions to my friends. |
| <input type="radio"/> Math helps me in my science class. | <input type="radio"/> I have Internet at home. |
| <input type="radio"/> I like to use a calculator in math class. | <input type="radio"/> I am good at estimating. |
| <input type="radio"/> I have a portfolio/folder for my math work. | <input type="radio"/> I feel confident talking about how math is used in real life. |
| <input type="radio"/> I like to learn new math ideas from computers. | <input type="radio"/> I like to write about mathematics. |
| <input type="radio"/> I like working with numbers more than words. | <input type="radio"/> Math helps me in my social studies class. |
| <input type="radio"/> I like using manipulatives to learn math. | <input type="radio"/> I feel confident learning math. |
| <input type="radio"/> I like working in small groups in math class. | <input type="radio"/> I like to learn new math ideas by working on difficult problems. |
| <input type="radio"/> I have a computer at home. | <input type="radio"/> I have my own calculator. |
| <input type="radio"/> I like geometry. | <input type="radio"/> I like to write math tests. |
| <input type="radio"/> My parents/guardians like math. | <input type="radio"/> I use a journal for my math work. |
| <input type="radio"/> Learning math is stressful. | <input type="radio"/> I like doing math homework. |
| <input type="radio"/> I am good at doing math in my head. | <input type="radio"/> I like mathematics. |
| <input type="radio"/> I would like to do more math in school. | <input type="radio"/> I think math is important to learn. |

How often? →

Fill in one circle for each statement.

18.

| | almost always | usually | sometimes | hardly ever |
|--|-----------------------|-----------------------|-----------------------|-----------------------|
| I <u>finish</u> math assignments that are <u>short</u> or <u>interesting</u> . | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I even <u>finish hard</u> math assignments or ones that are <u>boring</u> . | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I <u>need help</u> in math from my teacher or friends. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| If I have trouble with a math problem, I <u>skip it</u> and try the other questions. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| If I have trouble with a math problem, I get the teacher or a friend to <u>explain</u> it to me. That will <u>help</u> me do other problems by myself. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I come <u>prepared</u> for math class. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I try to do my <u>best work</u> when I do my math assignments. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| When I do a hard math problem, I work hard to get the answer by <u>myself</u> . | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| When I do a hard math problem, I <u>check</u> my notes and other books to help me try to solve it. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| During math class, I <u>pay attention</u> and <u>work hard</u> on class activities. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| If I have trouble with a math problem, I try to get a <u>hint</u> from the teacher or a friend. I like to get the answer by myself. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I <u>think about</u> what I did in math class and how I could do better. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| If I have trouble with a math problem, I ask the teacher or a friend to <u>give</u> me the answer so I get it <u>correct</u> . | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| If I have trouble with a math problem, I give up and <u>quit</u> my math work. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| How often do you need <u>help</u> with math from your parents/guardians? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| How often do the questions on your math tests <u>match</u> what you have studied? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I try to <u>figure out</u> how the math I learn in class might be useful in the real world or in my other subjects. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| As I learn new math ideas, I make sure I <u>think hard</u> about what I already know. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| When I am having trouble with a hard math problem, I use the internet to help me solve it. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

19. How often do you do your own math activities or projects outside of class time (just for fun)?

- ☐ almost every day
- ☐ once a week
- ☐ once a month
- ☐ once or twice a year
- ☐ never



Please answer the following questions
about your parents/guardians.

Fill in one circle for each statement.

20.

| | almost always | usually | sometimes | hardly ever |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| They are <u>interested</u> in how I am doing at school. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They ask me questions and <u>talk</u> with me about how things are going at school. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They often try to <u>help</u> me or get me help when I am doing school work. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| When they <u>ask</u> me about school, I try <u>not to talk</u> to them too much about it. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They <u>read</u> school items like newsletters, notes and my school agenda. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They <u>congratulate</u> me when I have done well at school. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They talk with me about how <u>important</u> school is. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They <u>believe</u> that I try hard and do good work. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They play board games or card games with me. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They tell me what they <u>expect</u> of me for school. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They <u>attend</u> school special events and parent-teacher interviews. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They ask me questions <u>about math</u> and encourage me to find answers. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They like to <u>help</u> me or work with me when I am doing my math homework. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They <u>do</u> my math homework for me. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| When they help me with math homework, they make sure I <u>understand</u> it. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They make sure I have books, magazines, equipment or computers at home, the school, or the library to help me learn math. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They <u>help</u> me learn math. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

21. Are you happy with how well your family supports your learning?

- ☐ Yes, I am.
- ☐ Yes, but sometimes I feel they are too involved.
- ☐ No, I would like them to be more involved.
- ☐ No, I would like them to be less involved.



Thank you for participating!

Appendix 2

AFL Math Assessment for Grade 5 Students in Saskatchewan



Saskatchewan
Learning

Grade 5



Multiple-Choice Booklet

Mathematics Assessment for Learning Program
2007

INSTRUCTIONS

- Do not put your name on this test.
- You can use a CALCULATOR for any part of this test.
- Please use the Help Sheet on page *ii* to help you answer the questions.
- Diagrams are not drawn to scale.
- Your answers to these questions are very important. Please think carefully about each question before you answer it. Try to answer ALL the questions.
- This booklet contains only multiple-choice questions.
- Mark all your answers for the multiple-choice questions on the scan form provided.
- In pencil, please shade in the circle beside the letter of the best answer (mark only one answer per question).
- Fill the circle in completely and do not put any marks on circles not selected. If necessary, please make sure that you have fully erased any changes.

| Example | | | |
|----------------------|--------|------------------------------------|------------|
| 1. What is $3 + 4$? | 1 a ● | 1 a ● | 1 a ● |
| | b ○ | b <input checked="" type="radio"/> | b ○ |
| | c ○ | c ○ | c ○ |
| | d ○ | d ○ | d ○ |
| | Good ↗ | Not good ↗ | Not good ↗ |

- When you finish, check over your booklet and your scan form. Make sure you answered or tried to answer all of the questions.

You may show your work beside each question.

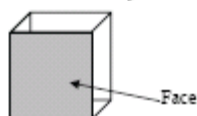
Help Sheet

Area is the total surface covered by a shape or region. It is expressed in square units (m^2 , cm^2 , etc.). To find the area of a rectangular figure, multiply the length and the width.

Averages are found by dividing the total of all of the numbers by how many numbers are in the group.

Congruent figures have the same size and shape.

Faces are the surfaces on a three-dimensional object.



Perimeter is the total distance around the outside of a figure. It is expressed in linear units (km, m, cm, etc.). To find perimeter you find the sum of the lengths of all the sides.

Symmetrical shapes are shapes that can be "folded" in half so that the two parts match. The line of symmetry is the "fold line".

Volume is the amount of space occupied by an object. It is expressed in cubic units (m^3 , cm^3 , etc.). To find the volume of a rectangular solid, multiply the length, the width, and the height.

OTHER

1 L = 1000 mL

1 dozen items = 12 items

1 km = 1000 m

1 m = 100 cm

1 m = 1000 mm

1 cm = 10 mm

1 min = 60 sec

1 hour = 60 min

1 day = 24 hrs

1 week = 7 days

1 year = 365 days



Think hard and do
your best on these
40 questions!

START



The strand and the objective that correspond to each multiple-choice question are included in the text box beside the question. Beside each distractor is one possible error that the student may have made if he/she chose that distractor.

1. Which of the following shows a shape and its reflection (flip)?

G – 22(b)
Geometry

a)



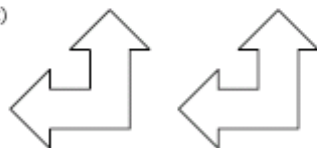
Student may have confused reflections and rotations.

b)



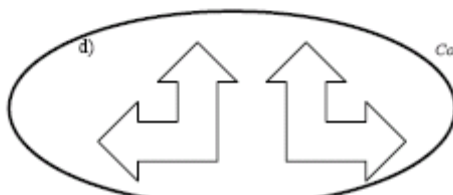
Student may have confused reflections and rotations.

c)



Student may have chosen a figure that is not flipped or rotated.

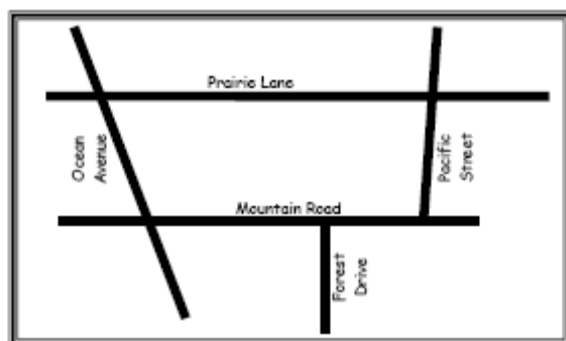
d)



Correct answer

2. Which street on the map below could be parallel to Mountain Road?

G – 17(b)
Geometry



- a) Forest Drive
b) Ocean Avenue
c) Pacific Street
d) Prairie Lane

Student may have chosen a line that is perpendicular to the given line.

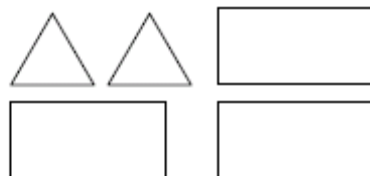
Student may have chosen a line that is intersecting the given line.

Student may have chosen a line that is intersecting the given line.

Correct answer

3. What three-dimensional object can be built using these faces?

G – 6
Geometry



- a) rectangular prism
b) rectangular pyramid
c) triangular prism
d) triangular pyramid

Student may have erroneously identified the base of the structure.

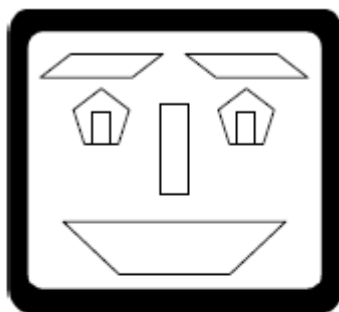
Student may have erroneously identified the base of the structure and has confused pyramid and prism.

Correct answer

Student may have confused pyramid and prism.

4. Which shape is NOT found in the picture below?

G – 13
Geometry



- a) parallelogram *Student may not know this shape or may not see it in the picture.*
b) pentagon *Student may not know this shape or may not see it in the picture.*
c) rhombus *Correct answer*
d) trapezoid *Student may not know this shape or may not see it in the picture.*

5. Beth typed her name using capital letters as shown below. How many letters from her name have more than one line of symmetry?

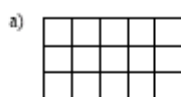
G – 23
Geometry

BETH

- a) one *Correct answer*
b) two *Student may have guessed.*
c) three *Student may have interpreted as the number of letters with exactly one line of symmetry.*
d) four *Student may have found the number of letters or thought four letters had multiple lines of symmetry.*

6. The grids below represent the floors of four different sheds found on a model of a farm. Which one has the greatest floor area?

M – 13
Measurement



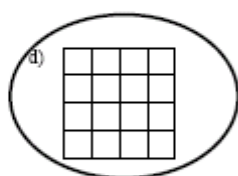
Student may have selected the response with the second largest area.



Student may have selected the response with the greatest width.



Student may have guessed.



Correct answer

7. A graduated cylinder with water in it is shown below. Approximately how much more water should be added to fill the container to the one litre marking?

M – 23
Measurement



- a) 250 millilitres
b) 500 millilitres
c) 750 millilitres
d) 1000 millilitres

Student may have indicated the amount of water currently in the cylinder.

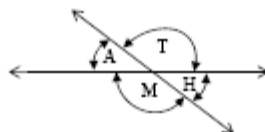
Student may have selected the amount of water needed to go from the middle marking to the top.

Correct answer

Student may have selected the total capacity of the cylinder or may not have subtracted the 250ml.

8. Which pair of angles below are **both less than 90°** ?

M – 67(b)
Measurement



- a) A and H
b) A and M
c) H and T
d) M and T

Correct answer

Student may have selected a pair with only one angle less than 90° .

Student may have selected a pair with only one angle less than 90° .

Student may have selected a pair with both angles more than 90° .

9. What information would you need to find the volume of any rectangular prism?

M – 38
Measurement



- a) height, length, mass
b) height, length, width
c) height, mass, width
d) length, mass, width

Student may have used mass in the calculation of volume instead of width.

Correct answer

Student may have used mass in the calculation of volume instead of length.

Student may have used mass in the calculation of volume instead of height.

10. When you check out the cost of movie rentals at Rodney's Video Store, you find the information below. Which deal has the lowest cost per movie?

M – 65(b)
Measurement

| Rental Deals | Cost of Deal | Number of Movie Rentals |
|--------------|--------------|-------------------------|
| Deal 1 | \$36 | 8 |
| Deal 2 | \$24 | 5 |
| Deal 3 | \$42 | 9 |
| Deal 4 | \$30 | 7 |



- a) Deal 1
b) Deal 2
c) Deal 3
d) Deal 4

Student may have selected the first item in the table.

Student may have selected the lowest total price or the least number of movies.

Student may have selected the highest number of rentals.

Correct answer

11. Susan bought a CD for \$15.99, a DVD for \$37.70, and batteries for \$2.60. She also paid \$6.19 in taxes. If she gave the cashier two \$20 dollar bills, two \$10 dollar bills, and one \$5 dollar bill, how much change did Susan get back?

M – 63
Measurement

- a) \$2.48
b) \$2.52
c) \$8.71
d) \$14.90

Student may have incorrectly subtracted the cents.

Correct answer

Student may not have subtracted the amount of taxes.

Student may have added the amount of taxes.

12. A nurse worked from 20:00 to 06:00. How many hours did the nurse work?

M – 50(c)
Measurement

a) 6

Student may have assumed that that 20:00 is midnight or just used 06:00.

b) 8

Student may have assumed work shifts are always 8 hours.

c) 10

Correct answer

d) 14

Student may have subtracted 20 – 6.

13. According to the chart below, which of the following Saskatchewan schools has the smallest student population?

D – 8(d)
Data Management

| School | Student Population |
|------------|--------------------|
| Bruno | 174 |
| Midale | 157 |
| Norquay | 214 |
| St. Brieux | 185 |

a) Bruno

Student may have selected the first item in the table.

b) Midale

Correct answer

c) Norquay

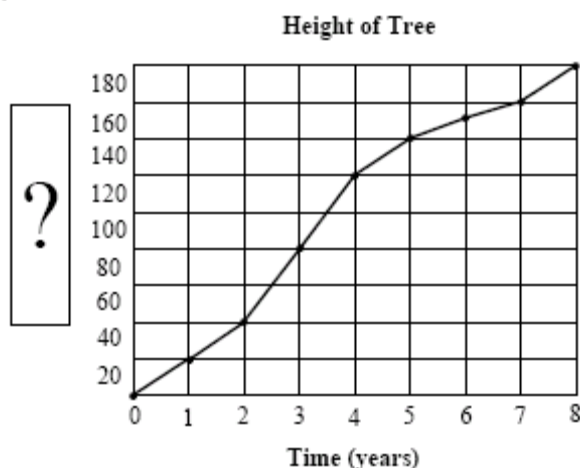
Student may have selected the response with the lowest tens digit.

d) St. Brieux

Student may have selected the last item in the table.



14. Which label should be put in the box on the left side of the graph below?



D – 6(h)
Data Management



- a) Age (months)
- b) Capacity (litres)
- c) Height (centimetres)**
- d) Mass (kilograms)

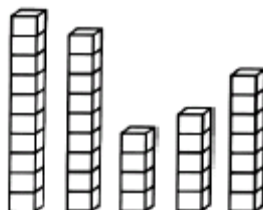
Student may have assumed the label should indicate the number of months.

Student may have assumed the label should indicate the tree's capacity.

Correct answer

Student may have assumed the label should indicate the tree's mass.

15. You are asked to create five equal stacks using the cubes shown below. How many cubes will be in each equal stack?



D – 8(g)
Data Management

- a) 5
- b) 7**
- c) 15
- d) 35

Student may have indicated the number of stacks.

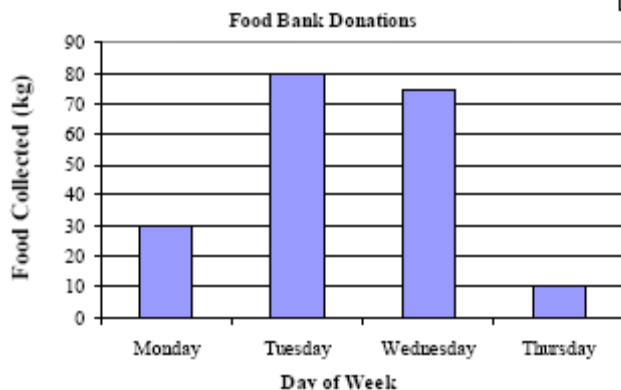
Correct answer

Student may have found the number of cubes needed to increase each stack to equal the highest stack.

Student may have found the total number of cubes.

16. The bar graph below shows how many kilograms of food was collected during the first four days of a Food Drive.

D – 9
Data Management



How many kilograms of food still needs to be collected on Friday to meet a goal of 250 kilograms?

- a) 55
- b) 80
- c) 170
- d) 195

Correct answer

Student may have found the amount for the highest day.

Student may have subtracted the highest day from the total goal.

Student may have found the total amount of food collected.

17. Which of the following is the best method for finding the change in the price of skates over the last several years?

D – 1(e)
Data Management



- a) Research what your parents paid for a pair of skates when they were kids.
- b) Research what stores charged for a pair of skates each year for the last twenty years
- c) Research the current price for a pair of skates and subtract a few dollars for every year.
- d) Research the current price for a pair of skates in several different sporting goods stores.

Student may not have realized that this would give an uneven comparison.

Correct answer

Student may not have realized that this would give an inaccurate price for each year.

Student may not have realized that this would only give a current price.

18. Jenny read 10 pages of her book every day for 30 days. Which of the following shows how many pages she read?

N – 68
Numbers and
Operations

a) 30×10

Correct answer

b) $30 + 10$

Student may have added instead of having multiplied.

c) $30 \div 10$

Student may have divided instead of having multiplied.

d) $30 - 10$

Student may have subtracted instead of having multiplied.

19. The number of points scored last season by the basketball team is shown below. If you were to estimate by rounding each score to the nearest 10, approximately what is the total number of points scored?

N – 48(f)
Numbers and
Operations

| Game | Points Scored |
|--------|---------------|
| Game 1 | 54 |
| Game 2 | 39 |
| Game 3 | 108 |
| Game 4 | 89 |
| Game 5 | 74 |
| Game 6 | 71 |
| Game 7 | 63 |

a) 460

Student may have used front end estimation or rounded everything down.

b) 490

Correct answer

c) 500

Student may have found the sum and then rounded to the nearest ten.

d) 530

Student may have rounded everything up.



20. Troy's lunch cost \$2.50 for a sandwich, \$0.65 for milk, and \$0.54 for a carrot. Which of the following shows the correct way to align these prices to find the total cost of Troy's lunch?

N – 108(b)
Numbers and
Operations

a)
$$\begin{array}{r} 2.5 \\ 0.650 \\ + 0.540 \\ \hline \end{array}$$

Student may have forgotten the zero at the end of \$2.50 and added an extra zero on the last two prices.

b)
$$\begin{array}{r} 2.5 \\ 0.65 \\ + 0.54 \\ \hline \end{array}$$

Student may have forgotten the zero at the end of \$2.50.

c)
$$\begin{array}{r} 2.50 \\ 0.650 \\ + 0.540 \\ \hline \end{array}$$

Students may have included an extra zero on the last two prices.

d)
$$\begin{array}{r} 2.50 \\ 0.65 \\ + 0.54 \\ \hline \end{array}$$

Correct answer



21. If you brush your teeth twice a day every day of the year, how many times will you brush your teeth in 2007?

N – 71
Numbers and
Operations



a) 104

Student may have multiplied the number of weeks in a year by two.

b) 183

Student may have divided the number of days in a year by two.

c) 365

Student may have forgotten to multiply the number of days in a year by two.

d) 730

Correct answer

22. Which of the following is the numeral for two hundred twenty-five thousand?

N – 29(e)
Numbers and
Operations

a) 225

Student may have written the numeral for two hundred twenty-five.

b) 2250

Student may have written the numeral for two thousand two hundred fifty.

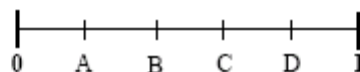
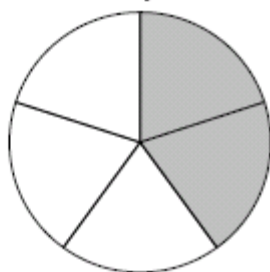
c) 22 500

Student may have written the numeral for twenty-two thousand five hundred.

d) 225 000

Correct answer

23. Which point on the number line represents the value equal to the fraction shown by the shaded portion of the circle?



N – 89
Numbers and
Operations

- a) A
b) B
c) C
d) D

Student may have assumed the fraction shown is one-fifth.

Correct answer

Student may have shown the value for the non-shaded portion of the circle.

Student may have assumed the fraction shown is four-fifths.

24. A pizza is cut into twelve pieces. If Todd eats $\frac{2}{3}$ of the pizza, how many pieces would Todd eat?

- a) 4
b) 6
c) 8
d) 12

N – 92(b)
Numbers and
Operations

Student may have divided the number of pieces by the denominator.

Student may have divided the number of pieces by the numerator.

Correct answer

Student may have assumed Todd will eat the entire pizza.

25. Ms. Reed wanted to place the 24 students in her class into groups that each had the same number of students. Which grouping would NOT work for her class?

- a) 3 groups of 8 students
b) 5 groups of 5 students
c) 6 groups of 4 students
d) 12 groups of 2 students

N – 73(b)
Numbers and
Operations

Student may have selected a grouping that are factors of 24.

Correct answer

Student may have selected a grouping that are factors of 24.

Student may have selected a grouping that are factors of 24.

26. The principal wanted to buy fish for each of the 15 aquariums in her school. If she purchased 75 fish, which number sentence below would show the number of fish each aquarium received?

N – 84
Numbers and
Operations

a) $75 \div 15 = 5$ fish

Correct answer

b) $75 \div 15 = 7$ fish

Student may have made a miscalculation.

c) $75 \div 5 = 15$ fish

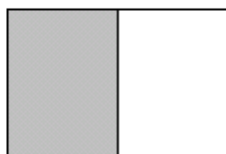
Student may have mentally calculated the correct number but represented it incorrectly.

d) $75 \div 7 = 15$ fish

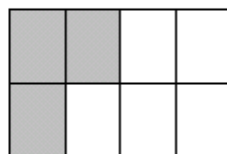
Student may have miscalculated and misrepresented.

27. Amanda and Brennon were painting the two sides of their backyard fence. Amanda painted $\frac{1}{2}$ of the fence on her side while Brennon painted $\frac{3}{8}$ of the fence on his side.

N – 97
Numbers and
Operations



Amanda's side of the fence



Brennon's side of the fence

Who painted more and by how much?

- a) Amanda painted $\frac{1}{8}$ of the fence more than Brennon.

Correct answer

- b) Amanda painted $\frac{1}{3}$ of the fence more than Brennon.

Student may have subtracted without finding a common denominator.

- c) Brennon painted $\frac{1}{8}$ of the fence more than Amanda.

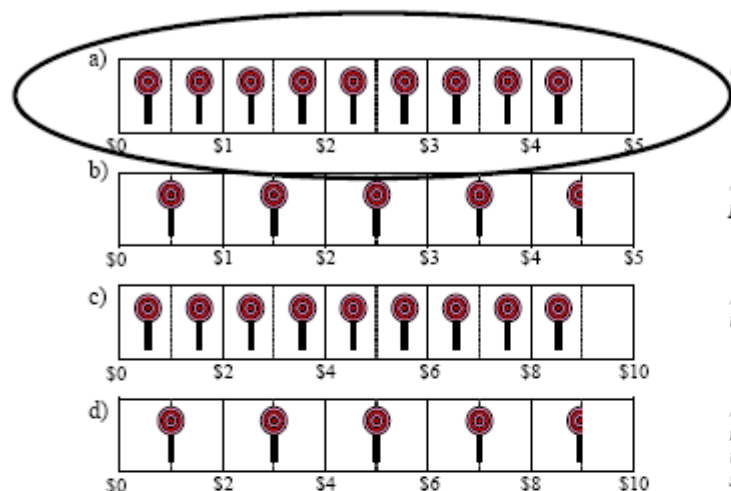
Student may have subtracted correctly but has assumed Brennon painted more of the fence.

- d) Brennon painted $\frac{1}{3}$ of the fence more than Amanda.

Student may have subtracted without finding a common denominator and has assumed Brennon painted more of the fence.

28. A sucker costs \$0.50 and you wish to purchase 9 suckers. If each represents one sucker, which of the following diagrams shows a way to find the total amount of money you would spend?

N – 110
Numbers and
Operations



Correct answer

Student may have assumed one picture represents two suckers.

Student may have used an incorrect scale.

Student may have used an incorrect scale and have assumed that one picture represents two suckers.

29. Which of the following represents the number 356 268 after rounding it to the nearest ten thousand?

N – 32
Numbers and
Operations

- a) 356 270
b) 356 300
c) 356 000
d) 360 000

Student may have rounded to the nearest ten.

Student may have rounded to the nearest hundred.

Student may have rounded to the nearest thousand.

Correct answer

30. Ashley bought three items that, after taxes, cost \$24.95, \$55.75, and \$28.95. The store offered a special of "buy three items and get the least expensive item free." How much did Ashley spend?

N – 98
Numbers and
Operations

- a) \$53.90
b) \$80.70
c) \$84.70
d) \$109.65

Student may have found the sum of the two cheapest items.

Student may have found the price of the least expensive and the most expensive items.

Correct answer

Student may have found the price of all three items.

31. Last week four students went to see a movie and paid a total admission of \$33.36 (tax included). What would be the exact cost of admission for a group of twenty students?

N – 109
Numbers and
Operations

- a) \$41.70
b) \$165.00
c) \$166.80
d) \$667.20

Student may have divided by 4 students and then multiplied by 5.

Student may have multiplied the dollar value only.

Correct answer

Student may have multiplied the price by 20 instead of by 5.



32. At the end of March, Giselle had 382 songs on her iPod and then did the following:

N – 51
Numbers and
Operations

| | Songs Added | Songs Erased |
|-------|-------------|--------------|
| April | 70 | 54 |
| May | 84 | 24 |

How many songs does she have on her iPod at the beginning of June?

- a) 150
b) 306
c) 458
d) 614

Student may have subtracted all of the songs in the table.

Student may have confused which songs to add and which ones to subtract.

Correct answer

Student may have added all of the songs in the chart.

33. The school library has 5035 hardcover books and 870 paperback books. One way to find the total number of books is to add 5000 and 900 to get 5900. What steps should then be followed to find the exact number of books?

N – 41(o)
Numbers and
Operations

- a) add 65 *Student may have added 35 and then added 30.*
b) add 35 and then subtract 30 *Correct answer*
c) subtract 65 *Student may have subtracted 35 and then subtracted 30.*
d) subtract 35 and then add 30 *Student may have subtracted the number that should have been added and vice versa.*



34. Which of the following equations represents a division sentence that is related to the multiplication sentence $3 \times 8 = 24$?

N – 83
Numbers and
Operations

- a) $3 \div 24 = 8$ *Student may have switched the dividend and the divisor.*
b) $8 \div 3 = 24$ *Student may have switched the quotient and the dividend.*
c) $8 \div 24 = 3$ *Student may have switched the quotient and the divisor.*
d) $24 \div 8 = 3$ *Correct answer*

35. Kelsey and Brant are each baking 3 dozen cookies for a class party. If the cookies are equally shared among 18 students, how many cookies will each student get?

N – 75
Numbers and
Operations

- a) 2 *Student may not have multiplied by two people.*
b) 3 *Student may have used the 3 from the 3 dozen.*
c) 4 *Correct answer*
d) 6 *Student may have multiplied the number of dozen by two.*

36. Which of the following fractions is closest in value to 1?

a) $\frac{7}{8}$

Correct answer

b) $\frac{8}{7}$

Student does not understand the fraction relationship.

c) $\frac{4}{3}$

Student does not understand the fraction relationship.

d) $\frac{3}{4}$

Student does not understand the fraction relationship.

N – 94(c)
Numbers and
Operations

37. Milkshakes cost \$3.00. What is the greatest number of milkshakes you can buy with \$10.50?

a) 3

Correct answer

b) 3.5

Student may not have rounded to the nearest whole number.

c) 4

Student may have rounded to the next highest whole number.

d) 7.5

Student may have subtracted $10.50 - 3$.



N – 114
Numbers and
Operations

38. You pay \$7.04 (tax included) to buy 2 boxes of Trident® gum. How much did each package of Trident® cost if each box contains 4 packages of gum?

a) \$0.44

Student may have divided by an extra factor of two.

b) \$0.88

Correct answer

c) \$1.76

Student may not have divided by the number of boxes.

d) \$3.52

Student may not have divided by the number of packages per box.

N – 117
Numbers and
Operations

39. How many decimal places would be in the product when you multiply 5.13 and any whole number between 1 and 9?

N – 112
Numbers and
Operations

- a) 1
- ☒ b) 2
- c) 4
- d) 9

Student may have assumed it will be only one decimal place.

Correct answer

Student may have doubled the number of decimal places.

Student may have chosen the highest number given in the question.

40. Cory needs one piece of string that is 0.68 meters long. String is available in $\frac{1}{4}$ metres, $\frac{1}{2}$ metres, $\frac{3}{4}$ metres, and 1 metre pieces. Which is the shortest length of string Cory could use?

N – 99
Numbers and
Operations

- a) $\frac{1}{4}$ metres
- b) $\frac{1}{2}$ metres
- ☒ c) $\frac{3}{4}$ metres
- d) 1 metre

Student may have selected the shortest piece of string.

Student may have guessed.

Correct answer

Student may have chosen the longest piece of string.



Appendix 3

Correlation Table for Questionnaire subset responses

Correlation Tables

| | Location | Gender | CQ6 | CQ7 | LQ8 | LQ9 | Confidence Q17-1 | ConfideceQ 17-20 | Confidence Q17-23 | Confidence Q17-29 | OutsideQ18- 17 | OutsideQ18- 19 | OQ19 | PARentQ20-1 | ParentQ20- 12 | ParentQ20- 13 | ParentQ20- 15 | ParentQ20-17 | PQ21 |
|------------------|----------|--------|--------|--------|--------|--------|---------------------|---------------------|----------------------|----------------------|-------------------|-------------------|-------|-------------|------------------|------------------|------------------|--------------|-------|
| Location | 1.000 | | | | | | | | | | | | | | | | | | |
| Gender | -0.004 | 1.000 | | | | | | | | | | | | | | | | | |
| CQ6 | 0.043 | -0.007 | 1.000 | | | | | | | | | | | | | | | | |
| CQ7 | 0.050 | -0.054 | 0.449 | 1.000 | | | | | | | | | | | | | | | |
| LQ8 | 0.023 | -0.002 | -0.193 | -0.176 | 1.000 | | | | | | | | | | | | | | |
| LQ9 | -0.034 | -0.047 | -0.030 | -0.022 | 0.035 | 1.000 | | | | | | | | | | | | | |
| ConfidenceQ17-1 | 0.018 | -0.093 | 0.333 | 0.340 | -0.174 | 0.016 | 1.000 | | | | | | | | | | | | |
| ConfideceQ17-20 | 0.011 | 0.007 | 0.226 | 0.245 | -0.103 | -0.026 | 0.214 | 1.000 | | | | | | | | | | | |
| ConfidenceQ17-23 | 0.017 | 0.011 | 0.350 | 0.364 | -0.183 | -0.020 | 0.376 | 0.319 | 1.000 | | | | | | | | | | |
| ConfidenceQ17-29 | 0.022 | -0.020 | 0.516 | 0.329 | -0.188 | -0.031 | 0.393 | 0.257 | 0.420 | 1.000 | | | | | | | | | |
| OutsideQ18-17 | -0.058 | 0.032 | -0.210 | -0.156 | 0.050 | 0.012 | -0.082 | -0.236 | -0.154 | -0.173 | 1.000 | | | | | | | | |
| OutsideQ18-19 | -0.056 | 0.035 | 0.047 | 0.068 | -0.137 | -0.016 | 0.059 | 0.016 | 0.070 | 0.066 | 0.085 | 1.000 | | | | | | | |
| OQ19 | -0.021 | -0.112 | -0.272 | -0.166 | 0.065 | 0.057 | -0.123 | -0.195 | -0.179 | -0.242 | 0.246 | 0.076 | 1.000 | | | | | | |
| PARentQ20-1 | -0.015 | -0.069 | -0.073 | -0.110 | 0.038 | 0.025 | -0.041 | -0.109 | -0.088 | -0.075 | 0.117 | -0.053 | 0.072 | 1.000 | | | | | |
| ParentQ20-12 | -0.058 | -0.028 | -0.107 | -0.111 | 0.021 | 0.059 | -0.036 | -0.171 | -0.101 | -0.092 | 0.237 | 0.063 | 0.201 | 0.263 | 1.000 | | | | |
| ParentQ20-13 | -0.056 | -0.032 | 0.005 | -0.041 | -0.032 | 0.039 | 0.027 | -0.092 | -0.022 | -0.004 | 0.156 | 0.073 | 0.074 | 0.227 | 0.401 | 1.000 | | | |
| ParentQ20-15 | -0.013 | -0.070 | -0.069 | -0.094 | 0.022 | 0.055 | -0.023 | -0.122 | -0.098 | -0.070 | 0.121 | -0.018 | 0.080 | 0.309 | 0.354 | 0.408 | 1.000 | | |
| ParentQ20-17 | -0.034 | -0.054 | -0.048 | -0.085 | 0.018 | 0.060 | 0.002 | -0.117 | -0.084 | -0.052 | 0.187 | 0.030 | 0.125 | 0.275 | 0.424 | 0.474 | 0.482 | 1.000 | |
| PQ21 | 0.021 | -0.034 | -0.144 | -0.157 | 0.116 | 0.032 | -0.102 | -0.115 | -0.148 | -0.115 | 0.070 | -0.039 | 0.085 | 0.172 | 0.184 | 0.201 | 0.245 | 0.277 | 1.000 |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |

Appendix 4

Factor Matrix of Full Questionnaire Responses

Student Questionnaire Rotated Factor Matrix(a)

| Question | Factor | | | | | | | | | | | | | | | | | | | | | | | | Count Significant Factor Per Question |
|----------|---------------|--------|--------|--------------|--------------|---------------|--------|--------------|--------------|--------------|--------------|--------------|---------------|--------|--------------|--------------|--------|-------------|--------|--------|--------|--------|---------------|--------|---------------------------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | |
| Q1a | -0.041 | -0.028 | -0.031 | 0.078 | 0.060 | 0.822 | 0.013 | -0.038 | 0.050 | -0.080 | 0.061 | -0.050 | 0.018 | -0.145 | 0.035 | 0.026 | -0.064 | 0.013 | -0.039 | -0.062 | 0.020 | 0.094 | -0.010 | 0.003 | 1 |
| Q1b | 0.067 | 0.060 | 0.020 | -0.029 | -0.013 | 0.020 | -0.033 | -0.103 | -0.005 | -0.014 | -0.030 | -0.029 | -0.029 | -0.049 | 0.012 | -0.032 | -0.052 | -0.100 | 0.002 | 0.018 | 0.043 | 0.041 | 0.043 | 0.043 | 0 |
| Q1c | -0.043 | -0.042 | -0.169 | 0.031 | -0.012 | 0.013 | -0.001 | 0.103 | 0.061 | -0.056 | -0.032 | 0.012 | -0.063 | 0.029 | 0.032 | -0.056 | 0.003 | 0.134 | -0.066 | 0.015 | 0.015 | 0.043 | 0.050 | -0.105 | 0 |
| Q2-1 | -0.018 | 0.048 | -0.020 | 0.007 | -0.006 | -0.197 | 0.077 | 0.036 | 0.065 | -0.001 | 0.313 | -0.032 | 0.018 | -0.007 | -0.026 | -0.013 | 0.051 | 4.06 | 0.000 | -0.050 | 0.050 | 0.068 | -0.055 | -0.097 | 1 |
| Q2-2 | -0.070 | -0.027 | 0.002 | -0.027 | 0.039 | -0.071 | 0.008 | 0.233 | -0.019 | 0.015 | 0.657 | -0.005 | 0.079 | 0.024 | -0.005 | -0.036 | 0.023 | 0.069 | -0.005 | 0.048 | -0.004 | 0.023 | 0.032 | -0.014 | 1 |
| Q2-3 | 0.045 | -0.121 | -0.097 | 0.022 | 0.411 | -0.113 | 0.019 | 0.049 | 0.005 | 0.120 | 0.055 | 0.009 | 0.021 | 0.026 | 0.067 | -0.032 | 0.052 | 0.043 | 0.099 | 0.061 | -0.030 | -0.123 | 0.055 | -0.043 | 1 |
| Q2-4 | 0.014 | -0.086 | -0.070 | 0.453 | 0.368 | 0.252 | 0.001 | 0.012 | 0.022 | 0.002 | 0.124 | 0.019 | 0.030 | -0.001 | -0.013 | -0.013 | -0.025 | 0.031 | -0.028 | 0.011 | -0.010 | 0.170 | 0.001 | -0.097 | 1 |
| Q2-5 | -0.036 | -0.015 | 0.062 | -0.091 | 0.237 | 0.033 | 0.007 | 0.047 | 0.020 | -0.002 | 0.628 | -0.008 | 0.040 | -0.007 | 0.046 | 0.042 | 0.035 | 0.066 | 0.015 | -0.026 | 0.009 | -0.028 | -0.033 | 0.032 | 1 |
| Q2-6 | 0.040 | -0.026 | 0.039 | -0.005 | 0.331 | 0.026 | -0.012 | -0.004 | 0.019 | -0.020 | 0.036 | 0.026 | 0.008 | -0.017 | -0.029 | 0.019 | -0.009 | 0.048 | -0.031 | 0.003 | -0.022 | 0.091 | -0.013 | -0.023 | 1 |
| Q2-7 | 0.053 | -0.020 | 0.032 | -0.063 | 0.455 | -0.022 | -0.038 | 0.008 | -0.003 | -0.005 | 0.063 | 0.034 | 0.022 | -0.017 | 0.031 | 0.045 | 0.071 | -0.017 | 0.015 | -0.039 | 0.029 | -0.055 | -0.023 | 0.109 | 1 |
| Q2-8 | 0.071 | -0.074 | -0.040 | -0.024 | 0.486 | 0.053 | -0.038 | -0.014 | 0.030 | -0.009 | 0.016 | -0.001 | 0.055 | -0.021 | -0.018 | 0.050 | -0.045 | -0.031 | -0.029 | 0.026 | -0.006 | 0.129 | -0.007 | -0.026 | 1 |
| Q2-9 | -0.001 | 0.055 | 0.075 | -0.104 | -0.063 | -0.598 | 0.002 | -0.031 | -0.014 | 0.006 | 0.314 | 0.003 | -0.015 | 0.013 | -0.034 | 0.003 | 0.053 | 0.208 | -0.082 | 0.019 | 0.026 | 0.096 | -0.037 | -0.023 | 1 |
| Q2-10 | 0.064 | -0.052 | -0.054 | 0.064 | 0.456 | 0.016 | -0.062 | -0.057 | 0.036 | 0.001 | -0.027 | 0.027 | -0.033 | -0.041 | 0.064 | 0.011 | -0.014 | -0.050 | 0.039 | -0.012 | 0.042 | -0.100 | 0.017 | 0.008 | 1 |
| Q3 | 0.066 | -0.153 | -0.156 | 0.101 | 0.022 | 0.198 | -0.018 | 0.095 | 0.127 | 0.024 | 0.067 | 0.015 | -0.004 | 0.077 | 0.021 | 0.014 | 0.027 | 0.218 | 0.051 | 0.053 | 0.029 | 0.022 | 0.091 | -0.097 | 0 |
| Q4 | -0.025 | -0.030 | -0.055 | -0.023 | -0.001 | -0.006 | 0.026 | 0.072 | 0.052 | 0.043 | 0.019 | -0.002 | 0.044 | 0.024 | 0.011 | -0.010 | -0.002 | 0.151 | 0.016 | 0.047 | 0.029 | -0.014 | 0.062 | -0.063 | 0 |
| Q5 | -0.109 | 0.174 | 0.169 | -0.050 | 0.017 | -0.080 | 0.077 | 0.022 | -0.093 | 0.005 | -0.034 | -0.048 | 0.017 | 0.040 | 0.000 | -0.077 | 0.178 | 0.088 | -0.079 | -0.008 | -0.034 | -0.027 | 0.039 | 0.103 | 0 |
| Q6 | -0.622 | 0.037 | 0.177 | -0.068 | -0.022 | -0.024 | 0.096 | 0.026 | -0.032 | -0.101 | -0.024 | 0.019 | -0.012 | -0.066 | 0.159 | -0.058 | 0.143 | 0.059 | -0.099 | -0.002 | 0.037 | 0.043 | -0.026 | 0.201 | 0 |
| Q7 | -0.376 | 0.100 | 0.284 | -0.058 | -0.016 | 0.029 | 0.048 | -0.018 | 0.034 | -0.227 | -0.028 | -0.005 | -0.003 | 0.100 | -0.128 | -0.042 | 0.171 | -0.001 | -0.141 | -0.081 | 0.035 | -0.017 | -0.063 | 0.119 | 1 |
| Q8 | -0.035 | 0.021 | 0.010 | -0.041 | 0.052 | -0.023 | 0.076 | 0.015 | 0.005 | -0.001 | 0.019 | -0.037 | 0.036 | 0.100 | -0.025 | -0.013 | 0.239 | 0.068 | -0.083 | 0.074 | 0.011 | 0.016 | 0.046 | 0.091 | 0 |
| Q9 | 0.003 | 0.025 | 0.006 | -0.028 | -0.006 | 0.001 | 0.006 | -0.018 | -0.005 | 0.004 | 0.010 | -0.029 | 0.009 | 0.061 | 0.008 | 0.030 | 0.016 | -0.059 | 0.002 | 0.002 | -0.001 | 0.035 | 0.052 | 0.161 | 0 |
| Q10 | 0.148 | -0.095 | 0.005 | 0.032 | 0.220 | 0.052 | -0.218 | 0.000 | -0.001 | -0.008 | 0.018 | 0.008 | 0.000 | 0.005 | 0.025 | 0.052 | -0.059 | 0.078 | -0.053 | -0.017 | -0.060 | 0.121 | 0.147 | -0.079 | 0 |
| Q11 | 0.076 | -0.032 | 0.028 | -0.043 | 0.122 | 0.002 | -0.062 | -0.043 | 0.001 | 0.030 | 0.046 | 0.567 | -0.022 | -0.022 | 0.156 | 0.001 | 0.012 | -0.026 | -0.001 | -0.003 | 0.025 | 0.068 | 0.018 | 0.1 | 1 |
| Q12 | 0.018 | -0.010 | -0.038 | 0.020 | 0.007 | 0.017 | -0.001 | 0.024 | 0.030 | 0.006 | -0.003 | 0.011 | -0.008 | -0.013 | -0.045 | -0.040 | 0.023 | 0.001 | 0.004 | 0.010 | -0.008 | -0.021 | 0.303 | 0.048 | 0 |
| Q13 | -0.006 | 0.035 | 0.010 | -0.030 | -0.031 | -0.020 | -0.022 | 0.005 | -0.034 | -0.005 | -0.044 | -0.019 | -0.525 | -0.001 | -0.004 | -0.039 | 0.002 | -0.060 | -0.057 | 0.007 | -0.011 | -0.024 | 0.061 | 0.026 | 1 |
| Q14 | 0.036 | -0.027 | 0.040 | 0.010 | 0.061 | 0.008 | -0.023 | -0.025 | 0.006 | -0.009 | -0.004 | 0.037 | 0.106 | -0.051 | 0.057 | 0.639 | 0.017 | -0.007 | 0.027 | 0.000 | 0.019 | 0.016 | -0.017 | 0.078 | 1 |
| Q15 | 0.040 | -0.038 | 0.038 | -0.031 | 0.069 | 0.005 | -0.079 | -0.009 | 0.021 | -0.081 | 0.009 | 0.151 | -0.035 | 0.201 | -0.447 | -0.059 | -0.012 | -0.037 | 0.009 | -0.017 | 0.043 | -0.136 | -0.037 | 0 | |
| Q16-1 | 0.135 | -0.093 | -0.176 | 0.057 | 0.056 | 0.032 | -0.044 | 0.051 | 0.154 | 0.002 | 0.019 | 0.082 | 0.010 | 0.011 | 0.065 | 0.018 | -0.079 | 0.013 | 0.212 | 0.018 | 0.020 | 0.022 | 0.009 | -0.186 | 0 |
| Q16-2 | 0.101 | -0.029 | -0.041 | 0.024 | 0.078 | 0.047 | -0.013 | 0.013 | 0.454 | 0.060 | -0.016 | 0.215 | 0.001 | -0.067 | 0.059 | 0.033 | -0.012 | -0.040 | -0.006 | 0.022 | -0.026 | 0.013 | -0.016 | -0.025 | 1 |
| Q16-3 | 0.029 | -0.064 | -0.143 | 0.082 | 0.025 | 0.035 | 0.012 | 0.045 | 0.652 | -0.002 | 0.014 | 0.026 | -0.024 | 0.031 | 0.056 | -0.018 | -0.005 | 0.038 | 0.084 | 0.017 | 0.039 | 0.036 | 0.042 | -0.037 | 1 |
| Q16-4 | 0.043 | -0.034 | -0.069 | 0.058 | 0.010 | -0.012 | 0.000 | 0.038 | 0.630 | 0.000 | 0.010 | 0.024 | 0.012 | 0.010 | 0.022 | 0.011 | 0.008 | 0.102 | -0.026 | -0.003 | 0.000 | 0.025 | 0.028 | 0.026 | 1 |
| Q16-5 | -0.037 | 0.000 | 0.068 | -0.153 | 0.012 | 0.022 | 0.058 | 0.005 | -0.112 | 0.004 | -0.016 | -0.049 | -0.076 | 0.039 | -0.003 | -0.026 | 0.068 | 0.014 | -0.136 | 0.027 | 0.050 | 0.010 | 0.008 | -0.025 | 0 |
| Q17-1 | -0.424 | -0.008 | -0.184 | 0.005 | -0.007 | -0.072 | 0.046 | 0.038 | 0.014 | 0.432 | 0.008 | 0.023 | 0.005 | 0.020 | -0.062 | -0.023 | -0.048 | 0.049 | 0.094 | -0.041 | 0.031 | 0.045 | 0.021 | 0.037 | 0 |
| Q17-2 | 0.544 | -0.039 | -0.066 | 0.022 | 0.066 | 0.013 | -0.057 | -0.013 | 0.033 | 0.007 | -0.037 | 0.002 | 0.000 | -0.015 | 0.098 | 0.062 | -0.075 | -0.012 | 0.013 | 0.052 | 0.033 | 0.013 | -0.013 | -0.042 | 1 |
| Q17-3 | 0.159 | -0.060 | -0.029 | -0.026 | 0.043 | -0.026 | -0.082 | -0.047 | 0.086 | 0.017 | 0.006 | 0.658 | 0.075 | -0.023 | 0.026 | 0.014 | -0.015 | -0.005 | 0.034 | 0.009 | -0.004 | 0.084 | 0.026 | -0.015 | 1 |
| Q17-4 | -0.175 | -0.003 | 0.140 | -0.111 | -0.020 | 0.014 | 0.054 | 0.044 | 0.010 | -0.104 | 0.011 | -0.016 | 0.048 | -0.120 | 0.270 | 0.082 | 0.020 | 0.024 | 0.008 | -0.019 | -0.025 | 0.111 | -0.342 | -0.019 | 1 |
| Q17-5 | 0.110 | -0.053 | -0.077 | -0.025 | 0.065 | -0.003 | -0.013 | -0.049 | 0.094 | 0.012 | 0.012 | 0.119 | 0.025 | 0.006 | 0.038 | 0.124 | 0.023 | -0.068 | 0.012 | -0.035 | -0.001 | 0.265 | -0.069 | 0.004 | 0 |
| Q17-6 | 0.117 | -0.057 | 0.064 | -0.074 | 0.064 | 0.000 | -0.122 | 0.045 | 0.002 | -0.027 | 0.012 | 0.048 | 0.419 | -0.058 | 0.252 | 0.018 | 0.032 | -0.001 | 0.000 | 0.010 | -0.015 | 0.089 | -0.015 | 0.056 | 1 |
| Q17-7 | 0.361 | 0.011 | -0.242 | 0.052 | 0.101 | -0.016 | -0.010 | 0.061 | -0.029 | -0.017 | 0.672 | -0.027 | 0.021 | 0.061 | -0.062 | 0.015 | -0.019 | -0.049 | 0.046 | -0.019 | 0.027 | 0.016 | -0.044 | 0.044 | 0 |
| Q17-8 | 0.033 | -0.042 | -0.010 | -0.006 | 0.022 | 0.009 | -0.017 | 0.045 | 0.135 | -0.062 | 0.010 | 0.063 | -0.019 | -0.074 | 0.409 | 0.118 | -0.056 | -0.048 | -0.019 | 0.021 | -0.020 | 0.064 | -0.129 | -0.084 | 1 |
| Q17-9 | -0.058 | -0.052 | 0.080 | 0.003 | 0.058 | 0.055 | 0.007 | 0.103 | 0.024 | -0.004 | 0.032 | 0.047 | 0.023 | -0.105 | 0.335 | 0.204 | 0.004 | 0.059 | 0.109 | -0.073 | 0.021 | -0.009 | -0.067 | 0.046 | 1 |
| Q17-10 | 0.002 | -0.091 | -0.057 | 0.023 | -0.006 | -0.009 | 0.023 | 0.695 | 0.041 | 0.015 | 0.069 | -0.010 | 0.015 | 0.003 | 0.069 | -0.016 | 0.012 | 0.161 | 0.038 | -0.016 | 0.021 | 0.033 | 0.004 | -0.006 | 1 |
| Q17-11 | 0.260 | -0.070 | -0.098 | 0.026 | 0.041 | -0.050 | -0.032 | 0.061 | 0.075 | 0.004 | -0.020 | 0.111 | 0.034 | -0.010 | 0.158 | -0.013 | -0.091 | 0.015 | 0.015 | 0.072 | 0.051 | 0.121 | -0.031 | -0.073 | 0 |
| Q17-12 | 0.237 | -0.196 | -0.021 | 0.019 | 0.074 | 0.043 | -0.016 | 0.101 | 0.015 | 0.027 | -0.033 | 0.097 | 0.014 | 0.018 | 0.118 | -0.042 | -0.045 | 0.003 | 0.054 | 0.030 | -0.011 | 0.000 | 0.026 | 0.011 | 0 |
| Q17-13 | -0.329 | 0.011 | -0.242 | 0.052 | 0.101 | -0.016 | -0.010 | 0.061 | -0.029 | -0.017 | 0.672 | -0.027 | 0.021 | 0.061 | -0.062 | 0.015 | -0.019 | -0.049 | 0.046 | -0.019 | 0.027 | 0.016 | -0.044 | 0.044 | 0 |
| Q17-14 | 0.378 | 0.012 | -0.162 | 0.039 | 0.034 | -0.137 | -0.001 | 0.030 | 0.056 | 0.307 | -0.001 | 0.063 | -0.018 | 0.039 | 0.003 | -0.056 | 0.026 | 0.003 | 0.049 | -0.143 | 0.040 | 0.063 | 0.062 | 0.086 | 1 |
| Q17-15 | 0.656 | -0.007 | -0.041 | -0.030 | 0 | | | | | | | | | | | | | | | | | | | | |

Appendix 5

Ethics approval of the study

1. Name of Supervisors

- a) Dr. Brian Noonan, Thesis Supervisor
Department of Educational Psychology and Special Education
- b) Dr. Laurie Hellsten, Thesis Supervisor
Department of Educational Psychology and Special Education

1a. Name of Student

- a) Hollis Lai, Master of Education student
Department of Educational Psychology and Special Education

1b. Anticipated start and completion date of the study

Start: May 15th 2008

Anticipated end date of research: September 2008

2. Title of Study

Factors Affecting Mathematics Achievement in Saskatchewan

3. Abstract

A recent release of an international math assessment program has found students in Saskatchewan are significantly underachieving compared to students of other provinces and Canada in general. Studies have found many extraneous factors to explain for variances in math scores. The purpose of the current study is to determine extra-curricular factors that affect the student's math achievement in Saskatchewan. Statistical analysis will be employed to investigate possible traits that aid students in achieving higher math scores. Results from a recent provincial math assessment administered to students in grades 5 and 8 will be used for the current study. The goal of the study is to provide a better understanding of the factors and trends unique to students in Saskatchewan. Software packages such as SPSS and LISREL will be employed to analyze the data.

4. Funding

There is no external source of funding used on this project.

5. Participants

The current study is conducting a secondary data analysis on data collected by Saskatchewan Learning. The participants of this study are 22,000 Saskatchewan students enrolled in grades five and eight students that participated in the Assessment for Learning (AFL) Math Assessment Program in the year 2007. As the data was already collected by AFL, all data has been deidentified and no direct contact will be made with the participants.

6. Consent

Permission to use the scores and questionnaires has been sought from the Executive Director of AFL program. A consent form and subsequent correspondence letters (See Appendix A) have been reviewed and signed by the researchers and submitted to AFL to ensure confidentiality of the data obtained.

7. Methods/Procedures

A literature review will be completed on the prevalent factors that have been thought to affect math achievement and scores of students. Those factors will be identified with the questions that are probed on the questionnaire given to the students after their math assessment in 2007.

The analysis will be conducted in 2 phases, the first phase will explore if there are relationships between the questionnaire questions and a latent factor suggested in previous literature using exploratory factor analysis, multiple regression models will also be employed to explore possible trends of the questionnaire questions and the students math achievement scores. The second phase would be to confirm for the relations as suggested by the models created and theorized from previous literature with multiple elements of math achievement broken down by learning objectives. The method of confirmatory factor analysis will be employed to report for findings of confirmed relations.

No contact will be directly made with the students that participated in the assessment as the present study is secondary data analysis oriented. All data will be deidentified and no attempts will be made to identify any record. All rules and regulations for the use of ministry data with the province of Saskatchewan will be agreed upon prior to data analysis.

8. Storage of Data

All research data including consent forms, response forms, transcripts and tapes will be stored in a locked file cabinet in the Department of Educational Psychology and Special Education office at the University of Saskatchewan. All electronic data will be pass-coded and stored physically in the locked cabinet. All accumulated data from the study will be kept for five years upon study completion by Dr. Noonan at the University of Saskatchewan. All data will be destroyed after five years of storage.

9. Dissemination of Results

The results of this study will be disseminated in the form of a thesis. Possible journal articles will be submitted to journals such as *The Alberta Journal of Education Research*.

10. Risk, Benefits, and Deception

The project presents no risk to participants as there is no direct interaction involved. The assessment results and questionnaire responses collected from the participants by AFL will be used for data analysis purposes. The results of this study will be communicated to Saskatchewan Learning, where the results will be available for subsequent testing, analyses, and policy review by educational researchers in the Saskatchewan education system.

11. Confidentiality

Any identifiable information regarding the participating schools and classes will be removed prior to obtaining the data from AFL. The focus of the present study is on the effect of extraneous factors on the overall achievement of students in Saskatchewan; therefore no individual results will be reported or needed. The participants of the study will not be contacted and any individually identifiable information will remain confidential will not be used throughout the analysis. A copy of the confidentiality agreement with Saskatchewan Learning is included (see Appendix A)

12. Data/Transcript Release

The dataset used in the present study will not be made public and will only be used for the purpose of the current study. Any subsequent data files created or modeling files created will be deleted as per stipulated in section 8.

13. Debriefing and feedback

Results of the study will be made available to the Electronic Thesis Database with the University of Saskatchewan upon completion.

Appendix A: Letter of Use (Sent via electronic methods)



Department of Educational Psychology and Special Education

March 18 2008

Darryl Hunter, Executive Director
Accountability, Assessment and Records
Ministry of Education
2220 College Avenue
Regina, SK S4P 4V9

Dear Mr. Hunter:

Re: Hollis Lai, Research Project

Thank you for your support for Mr. Lai's research project on factors that affect mathematics achievement in Saskatchewan. As we discussed earlier, please find attached a brief description of the project and a letter of agreement from Hollis with respect to using the Assessment for Learning data from the Ministry of Learning to undertake the research project. As you know Hollis has also been in communication with Rick Johnson regarding the project.

Thanks for your cooperation.
Please contact us if you have any questions or suggestions.

Sincerely,

Brian Noonan
Cc Hollis Lai

Factors Affecting Mathematics Achievement in Saskatchewan
Hollis Lai
Department of Educational Psychology & Special Education
University of Saskatchewan
2008

The purpose of this study is to examine the factors that affect mathematics achievement in Grades 5 and 8 in Saskatchewan schools. The researcher will use data from the recent Assessment for Learning program to explore the relationship between academic achievement and factors such as gender, rural urban settings, confidence in mathematics, locus of control, parent involvement, and other demographic variables. The results of the study will be useful to educators in developing ways to help improve student learning in mathematics.

Appendix B: Ethical use of data agreement



Letter of Agreement

For the use of data and collaboration of information with the Department of Accountability, Assessment and Records, Saskatchewan Ministry of Education.

I agree to the following conditions concerning the use of data accessed through the Saskatchewan Ministry of Education:

- The data will be used only for the purposes outlined in the description of the research project as submitted in prior communication.
- There will be no attempt to identify individuals or restore personal identifiers, including through such means as linkage with other databases or data triangulation. If personal identification of a depersonalized record is restored, wilfully or otherwise, all evidence of such identification will be destroyed, and the occurrence will be reported immediately to the ministry.
- All data will be treated in accordance with the *Freedom of Information and Protection of Privacy Act*. In addition, confidentiality will be maintained regarding school or school board information. The current research project will abide by ethical use of information guideline as set out by SSHRC, University of Saskatchewan and other research agencies involved.
- Data will not be shared, copied or otherwise made available to additional persons or parties.
- The security of data files and supplementary documents provided by the ministry will be maintained by keeping the information in a physically secure location to which access will be given only to authorized individuals in this project, namely Dr. Brian Noonan and Hollis Lai of the Department of Educational Psychology and Special Education, University of Saskatchewan.
- The Saskatchewan Ministry of Education will be acknowledged in any presentation or publication arising from the use of its data.
- The researcher will destroy any data or literature requested from the Ministry of Education 5 years after the proposed study has concluded.
- Custody and control of the data remains with Saskatchewan Ministry of Education.
- The provisions of this agreement that protect personal information survive the termination or completion of the project and the research thereunder.

Contact Information

Hollis Lai

MEd. Candidate

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Vita

Hollis Lai is currently a Master of Education candidate and research assistant at the University of Saskatchewan. He received his Honours Bachelor of Science degree specializing in Psychology from Wilfrid Laurier University and will continue his education with the Centre for Research in Applied Measurement and Evaluation at the University of Alberta. His research interest is in educational assessment methodologies and technology integration in assessment designs, but is generally interested in all things involving database integration and technology.